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APPARENT ERADICATION OF BACTERIAL RING ROT FROM SEED STOCKS OF A POTATO BREEDING PROGRAM[1]

R. B. O'Keefe and H. O. Werner[2]

Introduction

Bacterial ring rot (*Corynebacterium sepedonicum*) Skapt.-Burkh. was found late in the season of 1953 in an advanced clone of potatoes on the Box Butte Experimental Farm (dryland) of the University of Nebraska. In fields of growers where it was being increased, 15 per cent of the plants were infected. After critical field inspections and Gram staining (1) of selected plant specimens of a total of 78 clones in the initial seed increase program four additional clones were found to be infected. It has not been possible to determine the initial source of infection. It is thought that the presence of the disease was not detected in earlier years because of the early maturation of vines caused by drouth conditions and early killing frosts in some seasons.

The recommended method of disposing of all stocks of potatoes on a farm and replacing them with clean seed stock was impractical because not only these advanced selections but also seed stocks of more than 700 other irreplaceable clones of the Nebraska breeding program were involved in the program at the Box Butte Farm. Consequently, in order to salvage seed stocks and prevent further spread of the disease, a complete sanitary management and indexing program was inaugurated and has been continued since 1953. This involves plant indexing for ring rot freedom by Gram staining of stem smears, and increasing healthy stocks by means of a program involving disinfection of all equipment and facilities whenever tubers are handled. Vigilant precautions and field inspections are utilized to avoid any infection and to detect it promptly should any occur.

Methods and Procedures

Sanitary Management

Field Detection. Three to five critical row by row field inspections for the detection of ring rot are made each year; the first, 60 days after plant emergence, the others, at 7 to 10 day intervals. The stems of any plants actually or remotely expressing symptoms of ring rot are smeared and examined for Gram positive ring rot bacteria. In field identification stem-ooze (2) is also used as a criterion.

Harvesting. Clones planted in the increase program in blocks of one-thirtieth to five acres are harvested with a tractor-mounted digger equipped with a conveyor that places the tubers directly into clean baskets or bags. To avoid loss of a large stock of seed in the event of discovering infection in part of it, large lots are subdivided when harvested into three

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or more sub-lots whose identities are maintained in subsequent years. All dirt and debris are removed from the digger before thoroughly disinfecting it with copper sulphate solution (1 lb. per 10 gal. water) before any clone or sub-lot within clones is harvested (6). This spray, applied at high pressure with a spray gun, further insures the removal of small particles of dirt or debris and also drenches all surfaces with a disinfectant. Clones or sub-lots known to contain ring rot infection are harvested after all other potatoes have been harvested and immediately removed from the Farm. Prior to and during 1955, all sub-lots of an infected clone were disposed of as suspect of harboring infection.

All persons utilized for harvesting wear water-proof, rubber-coated work gloves. These are disinfected and washed clean with a saturated copper-sulphate solution before harvesting each clone or sub-lot.

In 1953 and 1954, potatoes were picked into rubber-covered wire baskets which were disinfected with a saturated solution of copper-sulphate. The potatoes were poured into new wooden bushel baskets, covered with new lids and tagged as a clone and sub-lot.

Since 1954, the harvesting procedure has been basically the same with the exception that disinfected rather than new bushel baskets have been used. Clones that are planted in blocks of one or more acres are harvested into new burlap 100-pound bags.

Hauling and Storage. As clones and sub-lots are harvested the baskets or bags are loaded on a flat bed truck, the bed and wheels of which are disinfected with formaldehyde (1 pt. per 10 gal. of water) before using and between loads.[3] The clones and sub-lots handled in baskets are stored in one storage. Larger lots handled in new sacks and certified seed (in bulk bins) are stored in another cellar on the Farm.

Prior to harvest, the concrete driveways and relatively tight wooden bin floors, bin boards, and walls of the storages are thoroughly cleaned and sprayed at high pressure with a copper sulphate solution (1 lb. per 10 gal.). During the harvest operation, driveways are kept free of debris at all times and frequently disinfected. After harvest is completed, the driveways are thoroughly cleaned and bin fronts and driveways are again disinfected and maintained in this condition throughout the storage period.

Sorting and Grading. During the early winter, clones in the initial seed increase stage, *i.e.*, those handled in baskets, are sized with a custom built sizer and waste tubers are removed. Seed tubers are returned to their original containers. This sizer is designed for efficient disinfection by elimination of inaccessible cracks and corners. It and the gloves of the sizing crew are thoroughly cleaned and disinfected with formaldehyde (1 pt. per 15 gal.) between the handling of clones and sub-lots. All working surfaces, including the floor, are kept wet with copper sulphate solution during the sizing operation.

A commercial type grader is used for large lots of seed. The disinfection procedures and precautions employed are the same as with the sizing of smaller lots, but copper sulphate, applied under high pressure, rather than formaldehyde, is used as the disinfectant for the grader. Excess solution is drained into a sump tank in the floor of the storage.

[3]In general, formaldehyde is used as much as possible because of its recognized effectiveness and penetrating ability. Copper sulphate is used with indoor operations and when the residual aspect might be important.

Seed Cutting. During the spring months the seed potatoes are dumped into a rack constructed on a metal-top cutting table. The tubers are cut part way through for tuber-unit planting with an assisted feed planter. The cutting table,rack, and rubber gloves of the seed handlers are disinfected with formaldehyde (1 pt. per 15 gal.). Formaldehyde is also used as the disinfectant for cutting knives. Tubers are returned to their original containers, healed at 65° F., and 90+ per cent R.H. for 5-7 days and then placed in cold storage awaiting planting time.

Planting. In order to insure adequate soil moisture for maintenance of vines in vigorous condition late into the season (for the detection of ring-rot) dryland plant spacing was increased by 50 per cent from the standard 14.5 x 40 inches to 18 x 48 inches. Tuber units are planted with an Iron Age assisted feed planter. The partially cut tubers are dumped into specially constructed small racks on the planter. The planter and racks are disinfected with formaldehyde (1 pt. per 15 gals.) between the handling of clones and sub-lots. The planter turn-table and sprout and seed handlers gloves are continually sprayed by means of pressure spray with fan type nozzles. After the completion of planting, all equipment, storages and baskets are thoroughly cleaned and disinfected.

To aid in detecting infection a 300-hill sample (150 tubers) is planted on irrigated land at the Scotts Bluff Experiment Station. With this test the cutting knife is disinfected only between lots, not between tubers within a lot. This is done to increase the percentage of infection within clones to aid in field detection if ring rot is present.

Indexing Program

In 1953, individual plants (hills) of advanced clones and seedling stocks which appeared to be healthy were staked and tagged for identification. The number of hills selected per clone varied, depending upon its apparent importance and stage to which it was to be increased. Smears were made of all stems of the selected plants. The smears were Gram stained and microscopically examined for ring rot bacteria, (1), (5). Tubers from healthy hills were aseptically hand dug, placed in individual paper bags and stored on shelves in a thoroughly disinfected room in the potato cellar. The following spring, cross sections of tubers were inspected under an ultraviolet light for ring-rot detection (3), (4). Surviving tubers were planted as tuber-units into an "index plot", utilizing aseptic methods as noted in the previous section. Beginning in late August, field inspections were made for the detection of infected plants. Diagnoses of infected specimens from "hill lines" were verified by Gram staining of stems, and if infected, all plants of the hill line were removed from the plot. Additional clone lines have been established in the index program of subsequent years. Each year six tuber-units of all hill selections within clones have been maintained and checked for ring rot. After three years of such observations the surplus seed from the hill selections has been bulked by clones and fed into the increase program.

In 1954, 116 hills of 29 clones within the seedling breeding stocks were selected for indexing. The tubers from each hill were examined for fluorescence under ultraviolet light. Gram stain techniques were not used.

The entire hill was discarded if fluorescence was observed in any tuber. Healthy hill selections are maintained and increased in the index plot.

After ring rot was discovered in the large fields of Redbake, being grown in 1954 for release to farmers, several hundred hills were selected and indexed for ring rot freedom. Both Gram-stain and ultraviolet light techniques were employed as previously described.

Management of Breeding Stocks

Upward of seven hundred clones of potatoes are maintained in the breeding program. Ten to 50 hills of each clone are planted at the Box Butte Experiment Farm each year. Disinfection procedures outlined for the sanitary management program are utilized in planting and harvesting the crop. Three to five pounds of tubers of each clone are hand picked and placed in new labeled paper bags for seed purposes. These bags are placed in new double burlap bags and shipped to Lincoln for cold storage.

The following spring, the stem end of each tuber is clipped with a disinfected knife and observed for fluorescence under ultra-violet light (4). All tubers that exhibit fluoresence are discarded regardless of type of fluoresence. Each healthy tuber of a clone is cut with a disinfected cutting knife. The pieces are distributed into new paper sacks for planting at the Box Butte Farm and in other test plots. Working surfaces, tuber trays, and gloves are disinfected between clones.

Clones from outside sources are handled in the same manner with the exception that they are planted in an "isolation lock" at the Box Butte Farm, where plants are observed and thoroughly checked for ring rot freedom before they are included in the regular breeding stock program.

Results and Discussion

Despite the vigilant sanitary management program, thirteen lines—in addition to the five lines of 1953—were found to be infected with ring rot by October 1954. These were in the seed increase program, and were aggregated in groups varying from two to five clones. Infection varied from 2 to 5 per cent. The grouping of infected clones might well be expected since clones within the increase program are systematically graded, cut and planted in the same order each year. No infection was found or has yet been found in any line which in 1953 had been in the program two years or less. This would indicate that the initial spread of infection probably occurred in 1950 or 1951.

In 1955, three additional clones were found to be infected, but since then no infected plants or tubers have been found in any of the clones in the Box Butte Farm increase program.

The results obtained with Gram-stain hill indexing in 1953 and 1954 are given in table 1. The efficiency of selecting for ring rot freedom by *vine appearance* ranged from 85.1 to 95.3 per cent, depending upon the source of the selected hills. The percentages of infected hills ranged from 4.7 to 14.9 per cent. Hill selection within clones in which the percentage of infection was greater than two per cent was less efficient than within clones in which ring rot had not been detected. Zero to 13.2 per cent of the infected hill selections were found to be infected by Gram-stain methods

TABLE 1.—*Summarized record of the results obtained with hill indexing for ring rot freedom in potato clones at the Box Butte Experiment Station.*

Source	No. Indexed		First Year			Second Year[1]	
	Clones	Hills	Healthy Per cent	Infected Per cent	Doubtful Per cent	Infected Per cent	Doubtful Per cent
Indexed 1953			By Gram Staining Method				
Breeding Stock (Isolation Block)	32	64	95.3[2]	0	0	3.1	1.6
Initial Increase							
From Infected	4	100	91.0[3]	4.0	5.0	..	..
From Clean	16	245	98.4[3]	0.4	1.2	..	..
Total	20	345	93.7[2]	1.4	2.3	1.2	1.4
Indexed 1954							
Initial Increase							
From Infected	12	480	88.0[3]	10.8	1.2	..	..
From Clean	7	144	91.6[3]	4.9	3.5	..	..
Total	19	624	85.8[2]	9.5	1.8	1.6	1.3
Redbake Increase	..	400	85.1[2]	12.7	0.5	1.0	0.7
			By Ultra-violet Light Method				
Breeding Stocks	29	116	94.8[2]	0	5.2	0	0

[1]Represents per cent missed by gram stain procedures.
[2]Represents efficiency of field selection for healthy hills.
[3]First year data only.

the first year. These percentages included both definite and doubtful smears. An additional 1.7 to 4.7 per cent infected selections were detected in the second year of indexing. Therefore, field selection plus Gram-staining were 95.3 to 98.3 per cent efficient in detecting ring rot freedom in the hill selections the first year. These percentages were probably higher depending upon the number of doubtful smears that actually represented healthy selections. No infected selections have been found in the index program since the second year of indexing.

Where only the ultraviolet light method was used for selection of ring rot free hills, 94.8 per cent of the selected hills were found free from the disease (Table 1). The remaining 5.2 per cent were in the doubtful category, *i.e.*, the fluorescence observed in the tubers could not be definitely attributed to ring rot. Ring rot infected selections have not been found in this group of material. This applies also to the several hundred breeding clones handled at Lincoln. The control of other virus diseases within the breeding stocks has been greatly improved since ultra-violet light has been used in selecting seed tubers.

The results of the indexing of Redbake for pre-introduction increases are shown in tables 1 and 2. Of the 400 hills selected by Gram-staining techniques at the Box Butte Experiment Farm, 13.2 per cent were found to be infected or in the doubtful category the first year and 1.7 per cent in the second year (Table 1).

In the index program with the variety Redbake at the Scotts Bluff Experiment Station 92.9 per cent of 1015 hills selected in the field were

TABLE 2.—*Summarized record of the results obtained with hill indexing for ring rot freedom in the variety Redbake (Scotts Bluff Experiment Station.)*

Number of Hills Indexed	First Year			Second Year		
	Gram-stain Healthy	U V Light		Mosaic	Spindle tuber	Ring rot
		Healthy	Doubtful			
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1015 (Stem Smears)	92.9	32.0		0.8	0.5	0.3
			17.1	0.2	0.3	0
995 (No Stem Smears)		29.9		0.4	0	0.1
			9.2	0.2	0	0

found to be healthy by Gram-staining of stem smears as shown in table 2. The following spring 43.8 per cent of these were discarded because of some type of fluorescence seen in tubers under ultraviolet light. Among the apparently healthy hill-lines 0.3 per cent were found to be infected in the field during the summer of 1955. Therefore, it is apparent that Gram-staining, in conjunction with ultraviolet light techniques, was 99.7 per cent efficient in selecting ring rot free hills the first year.

Of the 995 hills selected in the field for ring rot freedom, but not Gram-stain indexed, only 39.1 per cent failed to show some type of tuber fluorescence when ultraviolet light was used for detecting ring rot. The next summer only 0.1 per cent of these hill-lines was found to be infected. In this instance, ultraviolet light was as effective in selecting ring rot free hills as Gram-staining combined with ultraviolet light techniques.

This Redbake stock was released to commercial growers and the identities of hill selections were maintained in 1956. To date (November 1958) no ring rot has been found in any lots of Redbake seed potatoes.

SUMMARY

Bacterial ring rot was discovered in the seed stocks of five advance selections of the Nebraska program in 1953. The source of infection is unknown. The customary method of disposing of all potatoes on the farm was impractical because seed stocks of the hundreds of breeding clones were not available outside the Nebraska program. A comprehensive sanitary management and indexing program was inaugurated and has been continued since 1953.

Both Gram-staining and ultraviolet light techniques were utilized effectively in selecting and maintaining ring rot free hill selections within clones. At the dryland Box Butte Experiment Farm, the Gram-stain method as employed was 95.3 to 98.3 per cent efficient in detecting ring rot freedom in hill selections the first year. At the irrigated Scotts Bluff Experiment Station, the ultraviolet light techniques used alone were as effective in selecting ring rot free hills as Gram-staining used in conjunction with ultraviolet light techniques. The efficiencies of the two methods were 99.9 and 99.7 per cent, respectively.

Copper-sulphate and formaldehyde, of recommended concentrations, are utilized as disinfectants in all phases in the sanitary management of the potato program (1), (6). New or disinfected bushel baskets or new sacks are used for storage containers. To provide vigorous vines and insure plant survival until ring rot infection can be detected in the field, dryland plant spacing was increased and special irrigated plantings are made. Custom built harvesting and sizing equipment are utilized to reduce the likelihood of spreading ring rot infection.

Despite the vigilant initial efforts in 1953, infection was discovered in thirteen additional lines in 1954, and in three others in 1955. Since 1955 no infected plants or tubers have been found on the Box Butte Farm in any of the more than 1,000 clones in the breeding program.

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WAXING POTATOES — ITS EFFECT ON WEIGHT LOSS SHRIVELLING, DECAY AND APPEARANCE[1]

R. E. HARDENBURG, H. FINDLEN, H. W. HRUSCHKA[2]

Several investigators have reported that wax emulsions at dilutions common in commercial practice are of little value in reducing weight loss of potatoes during marketing (1, 2, 5, 9, 10). Although this experimental evidence is available, many packers still believe that one of the values of waxing potatoes is to reduce weight loss and shrivelling, perhaps because many commercial wax brochures make such claims.

Platenius (11) published a comprehensive study of wax emulsions for vegetables in 1939, but included little data on potatoes. In 1949, Lutz, Findlen and Ramsey (10) conducted waxing tests with Triumph potatoes after noting that use of colored wax was becoming a standard practice in the Red River Valley of Minnesota and North Dakota. They showed that waxing reduced weight loss slightly in comparison with unwaxed lots, but that this was of little commercial significance. They also reported that waxing with red colored wax masked somewhat but did not prevent greening. Hall (5) tested 10 commercial wax emulsions, including colored and non-colored types, on Pontiac potatoes in Florida. He found no significant differences in weight loss of the potatoes at the end of a month of storage at 70° F. in closed kraft paper bags between any of the emulsions or between the wax emulsions and non-waxed control lots. Colored waxes gave tubers a more uniform appearance than did non-colored waxes, but heavy applications gave an artificial appearance.

Kushman, Greene, and Ramsey (9) shipped color-waxed Triumph potatoes from Florida to northern markets. They found no significant differences in weight loss between waxed and non-waxed potatoes in 50-pound kraft bags either in transit or on holding. Cooking quality was not affected by waxing but the coloring matter came off in the water and penetrated any exposed flesh when potatoes were boiled without peeling.

Waxing potatoes usually has not affected the extent of decay. However, in 1948 there were some unsuccessful attempts to wax Kern County early White Rose potatoes. Decay in several cars following shipment was attributed to waxing. The same year Barger and Whiteman (2) of the U.S.D.A. made a transcontinental shipping test of waxed and non-waxed White Rose potatoes. They concluded that decay, especially from a lenticel type infection, was greatly increased by waxing.

One of the advantages claimed for color waxing is to improve appearance—to give red-skinned varieties a brighter and more uniform color. Greene (4) made a consumer acceptance study of color waxed Triumph and Red Pontiac potatoes. He reported a decided preference for color waxed potatoes when consumers were given an equal opportunity to buy

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both waxed and non-waxed potatoes at the same price. Another consumer survey by Kelly, Hemphill, and Bakken (8) indicated that more housewives would prefer waxed potatoes if the quality of the potatoes and of the waxing were improved. Waxing of inferior or bruised potatoes meant not only a waste of time and a loss of customers, but it actually accentuated external defects in potatoes.

Hruschka and Radspinner (7) investigated the necessity of using wax as a carrier for applying a sprout inhibitor. They concluded that water was a good carrier of sprout inhibitors. The use of wax as a carrier served no useful purpose in controlling sprouting.

Currently a fairly high percentage of red-skinned potatoes is treated with colored wax; whereas, in some areas, non-colored (clear) wax emulsions are used. At the request of the potato industry a series of tests in several producing areas was initiated in 1954. The objective was to further evaluate waxing and its effect on weight loss, decay, and appearance of both red- and white-skinned varieties.

Test Procedures

The basic test, of which 20 were conducted, consisted of examining waxed and non-waxed potatoes for weight loss and decay after storage at 40° and 70°F. in consumer bags. Both holding and shipping tests were made under commercial conditions in Maine, North Carolina and the Red River Valley area of North Dakota and Minnesota. Varieties included were Katahdin, Russet Burbank, Irish Cobbler, Triumph, and Red Pontiac. Several types of wax emulsions were tested, all of which were in use in commercial washing and packing plants. The concentration tested was the one in current use. Waxes were applied with various types of drip or foam waxing machines at a rate of approximately 1 gallon of wax (after dilution to 10,000 pounds of potatoes. Some wax emulsions were applied undiluted but others were diluted in 1:4 or 1:3 ratio with water. The wax emulsions were composed of blends of plant or mineral waxes with solids content ranging from 2 to 12 per cent. Most of those used on red-skinned potatoes contained small amounts of a mixture of FD&C Certified colors. Some emulsions contained the sprout inhibitor MENA (Methyl ester of alpha naphthaleneacetic acid) as pointed out in the results.

Washed and waxed samples, and samples which were washed only, were taken from the same production line and packaged in 10-pound kraft or polyethylene bags. The kraft bags were of double-wall wet-strength paper and in some instances had mesh windows. The polyethylene bags were 2.0-mil gauge and had 48 or 56 ¼-inch perforations. Three or six duplicate bags of all treatments were packaged for each test. After drying (often 24 hours) waxed and non-waxed lots were weighed and then reweighed at intervals up to 6 weeks' storage at 70° and 40° F. Relative humidity was low in the 70° storages (30 to 65 per cent) and high in the 40° storages (75 to 85 per cent) to simulate both retailing and good storage conditions.

For test shipments to terminal markets, potatoes were packed in kraft baler bags holding five of the 10-pound units. During storage following arrival, potatoes stored at 40° F. were left in the baler bags; those stored at 70° were removed from the balers and placed on shelves to simulate

retailing. Separate bags were used for determining weight loss and decay. For example, three bags were checked for weight loss and three other bags were opened and examined for decay. Weight loss was calculated as per cent of original fresh weight and decay as per cent of the total number of potatoes in each bag. No desprouting was done before weighing.

A number of smaller experiments were conducted on other aspects of waxing potatoes. For example, skinned and non-skinned potatoes were compared.

Results and Discussion

Weight Loss and Shrivelling. The effect of waxing on weight loss of 5 varieties of potatoes is shown in table 1. Table 1 and figure 1 show weight losses during 6 weeks' storage. Waxing had no consistent effect on weight loss of potatoes held or shipped in consumer bags. Often waxed potatoes lost slightly less weight during storage than non-waxed lots but the differences was not commercially significant. For example, in 3 tests with Red Pontiac potatoes stored 6 weeks at 70° F. in kraft bags, the mean weight loss of waxed and non-waxed tubers was 9.9 and 10.1 per cent, respectively (Table 1). Sometimes the reverse occurred and washed and waxed potatoes lost slightly more weight than potatoes which were washed but not waxed. For the 54 comparisons shown in table 1, the mean weight loss for washed and waxed lots was 3.3 per cent and for washed but not waxed lots 3.5 per cent.

As expected, weight losses were greater at 70° F. with low humidity than at 40° and high humidity. Usually they were 2 to 3 times greater at 70° after 6 weeks' storage in kraft bags. However, in tests with Red Pontiac in Minnesota where the relative humidity in the 70° storage was especially low (30 per cent) weight losses were up to 10 times greater at 70° than at 40° after 6 weeks' storage

The use of polyethylene consumer bags for minimizing weight loss was much more effective than waxing. Even though film bags were perforated with 48 or 56 ¼-inch holes for ventilation, weight losses were less than in kraft bags. Potatoes stored in perforated polyethylene bags lost only ½ to ⅔ as much weight as those in kraft bags at 70° F. and less than ½ as much at 40° (Table 1). Figure 1 shows that there was no appreciable difference in weight losses between non-washed, washed, or washed and waxed Katahdin potatoes following shipment from Maine to New York. The main difference shown is that polyethylene-packed potatoes lost less weight than those in kraft bags. These results with polyethylene are in general agreement with previously reported results (6, 10).

The effect of waxing on weight loss of severely skinned and non-skinned North Carolina-grown Triumph potatoes was determined by selecting the two types from a commercial packing line and then individually weighing all potatoes to the nearest gram. There were no significant differences in weight loss of waxed and non-waxed lots, either skinned or non-skinned, when potatoes were dried in air. Waxing cannot, therefore, be expected to prevent weight loss from heavily skinned potatoes. Weight losses were higher when washed and waxed potatoes were dried in a commercial dryer than when dried in air (Figure 2). The dryer apparently caused some increase in skinning. As expected, the difference

TABLE 1.—*Effect of waxing, storage temperature and type of 10-pound bag on weight losses of several varieties of washed potatoes during holding and shipping tests.*[1]

Variety, Place, Date and Treatment	Type of 10-pound Bag	Weight Loss (Cumulative Per cent)[2]					
		70° F. Storage			40° F. Storage[3]		
		2 Wks	4 Wks	6 Wks	2 Wks	4 Wks	6 Wks
Katahdin—Held Presque Isle, Me.: (2 tests, Nov., Dec., 1954)							
Washed	Kraft	3.0	4.6	6.0	0.3	1.3	2.2
Washed and Waxed[4]	Kraft	3.0	4.4	5.7	0.4	1.3	2.1
Katahdin—Shipped Maine to Md.: (2 tests, Jan. 1955, Jan. 1956)							
Washed	Kraft	4.4	6.9	9.8	1.6	2.2	2.6
Washed and Waxed	Kraft	4.3	6.8	9.3	1.6	2.1	2.6
Washed	Poly	2.6	5.0	7.4	0.5	0.6	0.8
Washed and Waxed	Poly	2.6	4.8	7.1	0.5	0.6	0.9
Russet Burbank—Shipped Maine to Md.: (2 tests, Jan. 1955, Jan. 1956)							
Washed	Kraft	4.5	6.5	9.0	1.8	2.3	2.9
Washed and Waxed	Kraft	4.2	6.0	8.1	1.8	2.3	2.8
Washed	Poly	2.9	4.6	7.0	0.5	0.7	0.8
Washed and Waxed	Poly	2.5	4.1	5.9	0.6	0.7	0.9
Triumph—Shipped N. C. to Md.: (1 test, June 1955)							
Washed	Kraft	3.1	4.4	5.2	2.0	3.0	3.6
Washed and Color Waxed	Kraft	2.4	3.6	4.4	1.2	2.1	2.7
Irish Cobbler—Shipped N. C. to Md.: (1 test, June 1955)							
Washed	Kraft	4.6	5.7	6.4	2.0	3.1	3.9
Washed and Waxed	Kraft	4.9	6.1	6.8	1.8	2.9	3.7
Red Pontiac—Held E. Grand Forks, Minn.: (3 tests, Feb., Mar. 1955)							
Washed	Kraft	3.6	6.7	10.1	0.7	0.8	0.9
Washed and Color Waxed	Kraft	4.0	6.6	9.9	0.6	0.8	1.0
(1 test, Sept., 1955)							
Washed	Poly	2.3	3.0	5.0	0.3	0.7	1.3
Washed and Color Waxed	Poly	2.3	3.3	4.3	0.3	0.3	0.7
Mean Weight Loss:							
Washed		3.4	5.3	7.3	1.1	1.6	2.1
Washed and Waxed		3.4	5.1	6.8	1.0	1.5	1.9

[1]Values shown for weight loss are means of 6 to 12 individual bags. All washing and waxing was done in commercial packing sheds. Usually the potatoes were allowed to dry 24 hours before the initial weights were recorded. Storage was in controlled-temperature rooms, and relative humidity was 30-65 per cent at 70° F. and 75-85 per cent at 40°. Varieties shipped were in kraft balers holding five 10-pound units. During holding following arrival the potatoes stored at 40° were left in the baler bags; those stored at 70° were removed from the balers and the 10-pound bags placed on shelves in a single layer to simulate marketing.

[2]Included any weight loss during transit in lots that were shipped.

[3]Except September, 1955 test with Red Pontiac potatoes, which were stored at 55° F.

[4]Wax used in holding test at Presque Isle, Maine contained MENA.

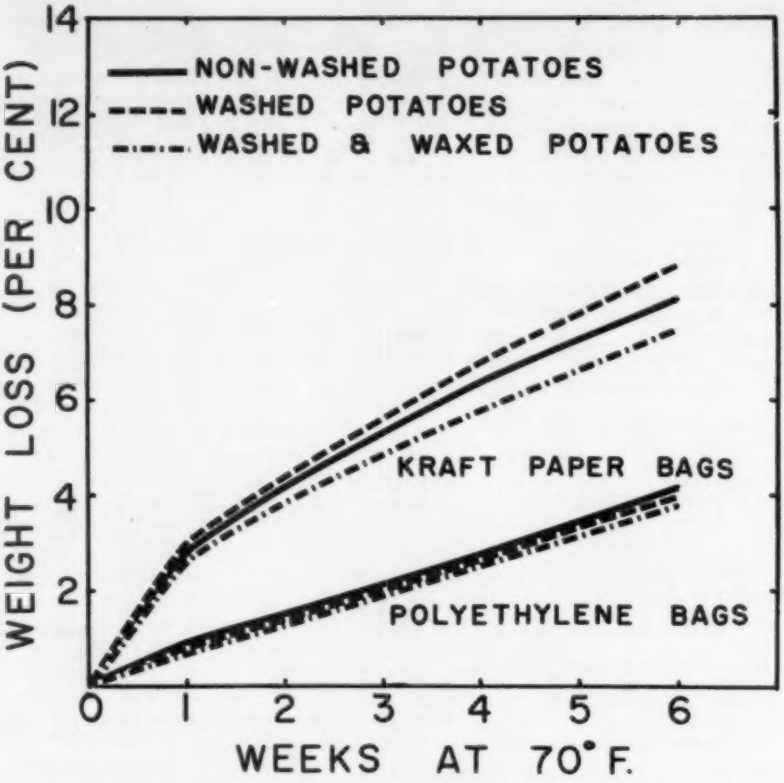

FIGURE 1.—Effect of washing, waxing and type of 10-pound bag on weight losses of Katahdin potatoes stored at 70° F. and 50-65 per cent relative humidity following rail shipment from Maine to New York, N. Y. (All values are means of two 9-bag tests during Dec.-Jan. 1954-1955. The 2.0-mil polyethylene bags had 48 ¼-inch perforations).

in weight loss of skinned and non-skinned potatoes was highly significant. During holding, skinned tubers lost 3 to 4 times as much weight as non-skinned tubers.

In another experiment, with U. S. No. 1 Red Pontiac, 6 commercial types of colored wax emulsions and a water solution of color only were compared for their effect on weight loss. Treatments were applied by dipping the tubers in the materials diluted 1:3 with distilled water. After drying in air at room temperature, the lots were weighed, placed in 4-quart till baskets, and stored at 72° F. and 30 to 35 per cent relative humidity. None of the waxes significantly reduced weight loss during a 4-week test conducted under rather severe conditions (Table 2). Moisture and volatiles in the 6 different wax emulsions ranged from 88 to 98 per cent, reflecting solids content (largely mineral or plant waxes) of 2 to 12 per cent.

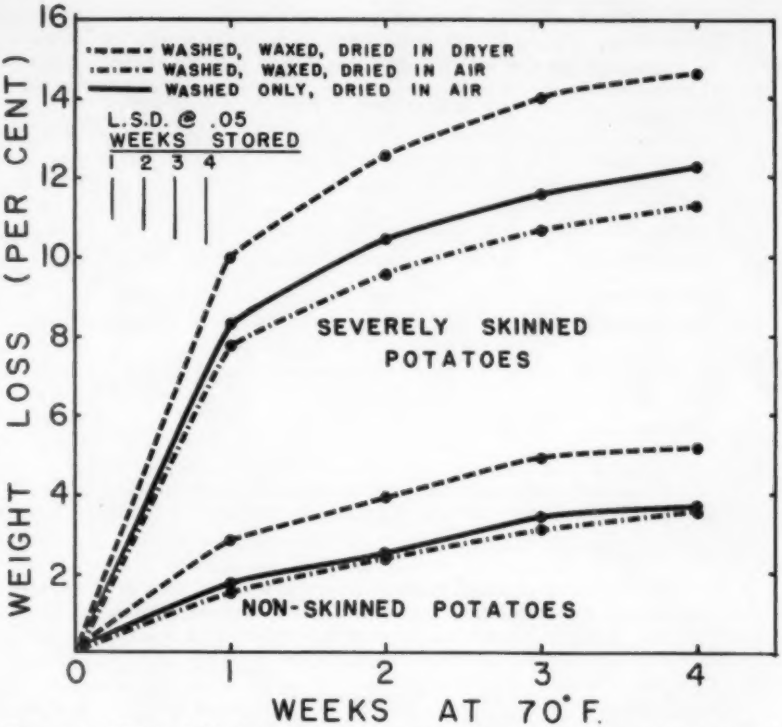

FIGURE 2.—Effect of skinning, color waxing and method of drying on weight losses of Triumph potatoes shipped in 10-pound bags from Elizabeth City, N. C., to Beltsville, Md. and stored at 70° F. and 55 per cent relative humidity, June 1955. (All values are means of three bags each containing 20 individually weighed non-skinned or severely skinned potatoes).

Visible shrivelling of potatoes occurred when weight losses reached 4 to 5 per cent. Waxing was of no value in reducing this shrivelling. With most varieties included in these tests, weight losses reached 4 to 5 per cent and moderate shrivelling developed after 4 weeks at 70° F. Shrivelling was severe after 6 weeks at 70°. Heavily skinned Triumph potatoes showed marked shrivelling and sponginess after only 1 week at 70°, with a weight loss of 7 to 10 per cent. No shrivelling was found in potatoes stored at 40° for 6 weeks.

Effect of Waxing on Decay. Extent of decay was recorded at each examination. Results were similar with most varieties, therefore data for only two shipping tests with Russet Burbank and Katahdin are given in table 3. In general, waxing with either clear-wax or color-wax emulsions had little or no effect on decay development of washed potatoes. Only slight decay developed in tests with Triumph, Irish Cobbler, Katahdin and Russet Burbank varieties during 6 weeks of storage at either 70° or 40° F. Decay was largely slow-growing Fusarium rot.

TABLE 2.—*Effect of various commercial wax emulsions on weight losses of Red River Valley Red Pontiac potatoes stored 4 weeks at 72° F. and 30-35 per cent relative humidity, January 1956.*

Treatment[1]	Moisture and Volatiles Per cent	Weight Loss[2] Per cent
Color Wax A	92.3	5.8
Color Wax B	88.3	6.2
Color Wax C	92.5	6.1
Color Wax D	92.0	6.2
Color Wax E	98.1	5.9
Color Wax F	87.8	6.4
Color only	99.7	5.9
Wet check	..	6.2
Dry check	..	6.3

[1]Each lot consisted of 10 tubers of approximately the same size with 4 replicates of each. Wax treatments were applied by dipping the tubers in the material diluted 1:3 with distilled water. All lots were air dried before weighing and storage in 4-quart till baskets.
[2]No significant difference between treatments.

TABLE 3.—*Effect of waxing, storage temperature and type of 10-pound bag on decay of Russet Burbank and Katahdin potatoes shipped from Maine to Washington, D. C.*[1]

Storage Period and Treatment	Storage Temperature ° F.[2]	Decay (Cumulative Per cent)				
		Russet Burbank		Katahdin		Mean (2 Varieties)
		Kraft Bag	Polyethylene Bag	Kraft Bag	Polyethylene Bag	
2 Week's Storage:						
Washed	70	0.8	1.3	1.1	2.7	1.5
Washed and waxed	70	0.5	0.3	0.5	1.8	0.8
Washed	40	0.2	1.6	0.6	1.9	1.1
Washed and waxed	40	0.2	1.9	0.2	2.6	1.2
6 Week's Storage:						
Washed	70	0.8	1.7	1.3	3.1	1.7
Washed and waxed	70	1.4	0.9	0.5	2.0	1.2
Washed	40	0.6	1.9	2.5	5.2	2.6
Washed and waxed	40	0.2	2.6	2.4	4.5	2.4

[1]Data based on 544 bags. Values are means of 12 bags from two shipping tests in January 1955 and January 1956 (6 bags per treatment for each test). Kraft bags were double-wall wet-strength paper with mesh windows. Polyethylene bags were 2.0-mil gauge with 48 or 56 ¼-inch holes. Stored at Beltsville, Maryland, following arrival.
[2]Potatoes held at 40° F. were in kraft baler bags holding five 10-pound units; those held at 70° were removed from the baler bags following shipment and the 10-pound units arranged on shelves in a snigle layer. Relative humidity at 70° was 35-40 per cent and at 40° was 85-90 per cent.

Some data were obtained showing that waxing freshly harvested potatoes may increase bacterial decay if potatoes are held under adverse conditions. In one test freshly harvested Red Pontiac potatoes were stored at 72° and 80° F. in non-perforated polyethylene bags. After 6 days' storage, 27 per cent of the waxed potatoes stored at 72° and 41 per cent of those stored at 80° were seriously affected with bacterial soft rot in contrast with only 2 per cent in non-waxed potatoes. Most of the infection started in the lenticels. In another waxing test in 1956 with freshly harvested U. S. No. 1, size B, Red Pontiac potatoes, similar results were obtained. After 1 week at 78° in non-perforated polyethylene bags color-waxed lots had 34 per cent decay in contrast to 12 per cent decay in non-waxed lots, as shown below:

Percentage Bacterial Decay of Potatoes in Non-Perforated Polyethylene Bags.

Treatment	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Mean
Washed only	12	18	4	16	12
Washed and color Waxed	32	22	54	30	34

Similar potatoes stored 1 week at 55° and then transferred to 78° and held an additional week developed little decay, either waxed or non-waxed. Apparently storage for 1 week at 55° retarded bacterial growth yet allowed closing layers to form in the lenticels, thus largely preventing bacteria from entering.

These two experiments were conducted under severe conditions and, of course, non-ventilated film bags are not recommended. However, adverse conditions of packaging and handling occasionally occur. This could account for scattered reports of some shippers and receivers that waxing freshly harvested potatoes increased soft rot. In another test lenticel pitting was much worse in waxed Red Pontiac potatoes than in non-waxed potatoes. This lenticel pitting did not markedly affect appearance and usually no decay was associated with it.

Appearance. Most potato packers using colored wax on red-skinned potatoes said that they were doing this to enhance the appearance. Observers in these studies agreed that usually the appearance of red-skinned varieties was improved by color waxing, largely by increasing color intensity. Sometimes excess color was added, giving an artificial appearance that was not an improvement. Judges could easily detect color-waxed samples from untreated ones.

Cooking tests were conducted with color-waxed Triumph and Red Pontiac potatoes boiled without peeling. In each test the red color came off the waxed potatoes and was clearly noticeable in the cooking water. When samples were washed in cold water before cooking most of the dye was removed from the potatoes without staining the hands. However, when a color-waxed sample was peeled without washing, it stained hands and exposed surfaces of the potatoes slightly. The stain was easily washed from the potatoes, but a slight amount of red color remained on the hands even after washing.

The practice of using artificial color on potatoes has resulted in many unfavorable consumer complaints to the Food and Drug Administra-

tion. Because of complaints, 11 states now have food regulations prohibiting sale of color-waxed potatoes. About 30 other states permit sale of color-waxed potatoes if damage or inferiority is not concealed by the treatment (3). In these test color waxing of red-skinned potatoes covered up or masked some defects such as greening, scurf, and sometimes skinning. Often, however, colored wax did not adhere well to skinned surfaces and potatoes then had a patchy, artificial appearance.

Clear waxes (no color added) had no consistent beneficial effect on appearance of washed Katahdin, Russet Burbank, Irish Cobbler or Red Pontiac potatoes. A few observers noted a slight improvement in brightness through use of a clear wax, but most could not distinguish between waxed and non-waxed lots. Clear waxes did not cover up or prevent greening nor did they seal or make skinned areas less noticeable.

The extent of sprouting was not changed by waxing when no sprout inhibitors were involved. If sprout inhibitors were included in wax emulsions sprouting was markedly reduced. Hruschka and Radspinner (7); however, recently showed that water was as good as wax as a carrier of sprout inhibitors. No sprouting occurred with newly harvested potatoes, either waxed or non-waxed, during 6 weeks' storage at 40° or 70° F. In tests initiated after potatoes had been in cold storage for 2-4 months sprouting of both waxed and non-waxed lots was serious in consumer bags after 3-4 weeks at 70°.

Summary

Commercial clear and colored wax emulsions were evaluated in potato-producing regions of Maine, North Carolina, and the Red River Valley of Minnesota and North Dakota on washed Katahdin, Russet Burbank, Triumph, Irish Cobbler, and Red Pontiac varieties. Waxed and non-waxed lots were packaged in 10-pound bags and held 6 weeks at 40° or 70° F. in production areas or after arrival in terminal markets .

Waxing was of little or no value in reducing weight loss or shrivelling of potatoes. Waxing heavily skinned new potatoes did not retard weight loss. The use of polyethylene bags and refrigerated high humidity storage were much more effective than waxing for retarding weight loss.

Little decay developed in either waxed or non-waxed potatoes in most tests and the amount was not affected by waxing. Under adverse holding conditions of high temperature and high humidity, waxing newly harvested Red Pontiac potatoes increased soft rot. In another test with Red Pontiac potatoes, waxing greatly increased lenticel pitting at 70° F. Wax emulsions used alone, without sprout inhibitors, had no effect on sprouting.

Clear wax emulsions had little or no effect on appearance of either red- or white-skinned potatoes. Usually judges could not distinguish waxed from non-waxed lots. Red wax, if applied uniformly, tended to improve color of red-skinned varieties by increasing color intensity. Excessive application made potatoes look artificial and was undesirable.

A disadvantage of colored wax emulsions was that the red dye discolored hands and tubers during peeling. The stain was easily washed from peeled potatoes but not so easily from the hands. Potatoes boiled, without peeling, discolored the cooking water as the dye came off. Colored waxes also concealed some potato defects such as greening.

Wax emulsions, either clear or colored, were ineffective in reducing weight loss, shrivelling, decay, or otherwise improving keeping quality. Possible improvement of brightness and color of red-skinned potatoes through use of a colored wax may be the only value.

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CHANGE IN THE PHYSICAL CONDITION OF STARCH OF THE POTATO DURING PRECOOKING HEATING[1]

A. L. Potter, E. M. Neel, R. M. Reeve, and C. E. Hendel[2]

This report concerns a change that occurs in the physical condition of starch in potatoes during treatment before cooking. Reeve (7, 8) showed that texture is greatly altered if potatoes are preheated by holding in water at about 75° C. (167° F.) for 30 minutes or more before they are cooked. The potatoes become very firm, and they do not slough, even after prolonged cooking. Cording, Willard, and co-workers found that mealiness of potato flakes is markedly improved by this heating prior to cooking (2, 3). They also reported improved quality of dehydrated products such as diced potatoes and potato granules (2). Harrington *et al.* (4) found that heating before cooking can improve potato granules produced by the add-back process by reducing the amount of soluble starch. Studies here indicate that the treatment, or modifications of it, may have application to a number of other potato products: canned potatoes for greater firming, dehydrated diced potatoes for firming, and potato chips for reduction of blistering (5).

Prevention of sloughing by preheating is illustrated in figure 1, which shows potato dice that were cooked in boiling water for 45 minutes. The sample on the left had been heated first for 60 minutes at 65° C. (149° F.) The other sample was not heated before cooking. The potatoes that were preheated sloughed very little, while those that were not preheated sloughed considerably.

The range of temperatures, 60° to 82° C. (140° to 180° F.), used in preheating is at or just above the temperature, 60° C. (140° F.), at which potato starch granules gelatinize. At these temperatures the starch granules absorb water and swell. In this condition the molecules have some degree of freedom to move; therefore it is possible that they can orient and associate. It is known that starch molecules in solution become associated by hydrogen bonding (1). This association results in a decrease in the solubility of starch, and is referred to as "retrogradation". Retrogradation of starch in solutions or pastes is very pronounced at temperatures lower than the preheating temperatures. Sair and Fetzer (9) and Whittenberger and Nutting (11) have shown that heating potato starch under conditions of high humidity also alters its physical pproperties. It therefore seemed possible that retrogradation occurs during preheating, and the present studies were conducted to test this possibility.

Experimental

Preparation of Starch Pastes. Starch suspensions were prepared by combining 15 grams of potato starch with 85 grams of distilled water in

[1] Accepted for publication April 16, 1959

[2] Western Regional Research Laboratory, Albany, Calif. A laboratory of the Western Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

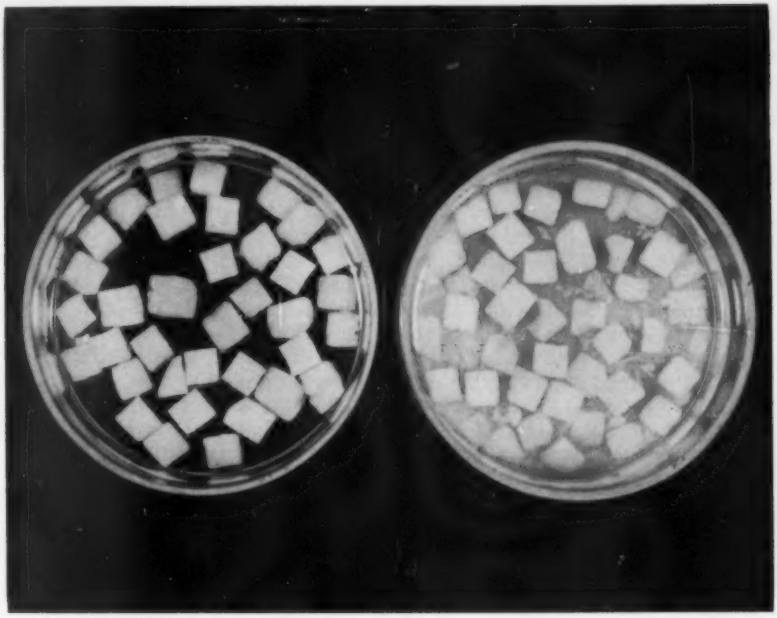

FIGURE 1.—Comparison of cooked potato dice which have been preheated (left) and not preheated (right).

Erlenmeyer flasks. The flasks were placed at a 30° angle to the vertical in apparatus of the type used for vacuum evaporation of solvents. The precooking heating treatment consisted of rotating the flasks at 71 rpm. in a constant temperature bath at 65° C. (149 F.) for 0 to 120 minutes. All flasks were then rotated for 20 minutes in a boiling water bath.

Determination of Solubility of Starch Pastes. One hundred ml. of water were added to the cooked suspension and the mixture shaken for 15 minutes on a mechanical shaker. Two hundred ml. of water were added and the mixture was shaken briefly by hand and filtered. The starch content was determined in the filtrate by the anthrone method (6) and the total starch dissolved from 100 grams of the original starch suspensions was calculated.

In addition to determining the dissolved starch from pastes that had been preheated and cooked, the starch dissolved from 15 per cent starch suspensions that had been cooked different periods of time was determined.

Determination of Dissolved Starch from Preheated and Cooked Potatoes. Potato dice, ⅜-inch cubes, were placed in a basket in a constant-temperature water bath at the desired preheating temperature (60° to 75° C. (140° to 167° F.)). Samples were removed at various periods of time (0 to 180 minutes), steamed for 20 minutes, and cooled in water at room temperature for 15 minutes. The dice were then pressed through a

perforated disc (2-inch diameter, 1/64-inch thick, with 1/32-inch holes on 5/64-inch staggered centers) in a Laboratory Carver Press.[3] A 25-gram sample of the riced potatoes was suspended in water by shaking, and diluted to 500 ml. The mixture was filtered and the soluble starch in the filtrate was determined by the anthrone method (6).

Results

Figure 2 shows amounts of starch dissolved from starch pastes prepared with the preheating step. As the time of preheating was increased the amount of dissolved starch decreased. These data indicate that during preheating the starch had undergone a form of retrogradation. There had been some association of the molecules so that heating in a boiling water bath did not gelatinize the starch to the same degree that occurred in pastes prepared without preheating. When samples of starch pastes were not preheated, the amount of starch dissolved increased as the time of cooking increased (Figure 3). This effect is the opposite of that found when the preheating time was increased. The fact that dissolved starch increased with cooking time for starch pastes that were not preheated shows that at the temperature of cooking (100° C. or 212° F.) aggregation of molecules does not occur as it does during preheating. This observation indicates that the decrease in solubility which occurs if the samples are preheated

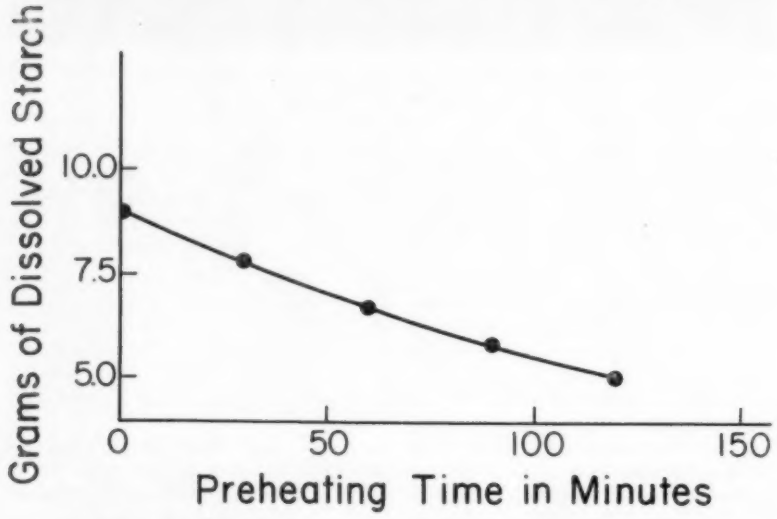

Figure 2.—Effect of preheating at 65° C. on amount of strach dissolved from 15 per cent starch pastes. All pastes were cooked 20 minutes at 100° C.

[3]Mention of products does not imply endorsement by the U. S. Department of Agriculture.

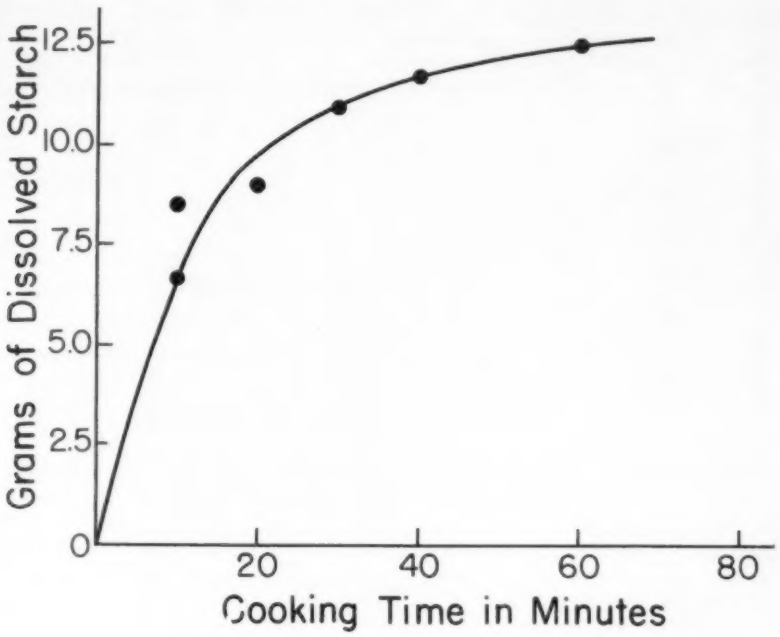

FIGURE 3.—Effect of cooking time on amount of starch dissolved from 15 per cent starch pastes.

is not due to a longer heat treatment, and it demonstrates that starch does retrograde at the preheating temperatures.

Determination of the solubility of starch in potato tissue is difficult. It is necessary to break the cell walls, so that the starch will be available for analysis, but the action must be so gentle that the structure of the swollen starch granules within the cells is not completely broken. When a blender was used, practically all the starch could be dissolved. The method described in the experimental section partially meets the requirements. Only part of the potato tissue cells are broken. Microscopic examination of the riced material showed more broken cells from preheated dice than from those that were not preheated. Therefore one would expect that more starch could be dissolved from the samples that were preheated. This is not the case.

Figure 4 shows the effect of preheating on the amount of starch dissolved from Russet Burbank potatoes. Three preheating temperatures, 60°, 65°, and 75° C.(140°, 149°, and 167° F.), were used. The response was about the same at all temperatures. The amount of soluble starch decreased with increased preheating time, but heating beyond 60 minutes resulted in little additional change.

White Rose potatoes gave results similar to those obtained with Russet

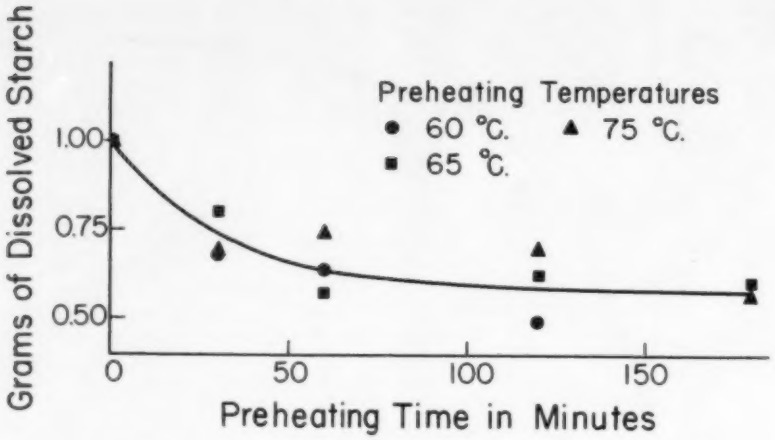

FIGURE 4.—Effect of preheating on amount of starch dissolved from Russet Burbank potatoes. All potatoes were cooked 20 minutes at 100° C.

Burbank potatoes. White Rose potatoes were also steamed for various periods of time without preheating. As cooking time increased, the amount of starch dissolved increased. This finding corresponds to the response of potato starch suspensions.

DISCUSSION

Whittenberger and Nutting (12) and Whittenberger (10) have suggested that the principal cause of sloughing may be associated with the swelling capacity of starch during gelatinization, which develops pressure within cells sufficient to fracture mechanically the intercellular cement. Data presented here show that during preheating the starch retrograded and therefore its swelling capacity decreased. Retrograded starch has been shown to swell less than starch that has not retrograded (6). The foregoing suggests that retrogradation of starch in potatoes during preheating may contribute to greater firmness and reduced sloughing of the potatoes after cooking, although other factors may also be involved.

SUMMARY

In the processing of dehydrated mashed potatoes it has been found that a heating treatment before cooking improves the quality of the product. The temperatures of preheating are at or just above the temperature of gelatinization of potato starch granules, 60° C. Data presented here show that gelatinized starch retrogrades, that is, becomes less soluble, if held at these temperatures. The rates of retrogradation at three temperatures, 60°, 65°, and 75° C., were about the same. After 60 minutes of preheating there was little further decrease in dissolved starch. Increasing cooking time of samples that were not preheated increased the amount of starch

dissolved. These data suggest that the improved quality of dehydrated mashed potato products is due, in part at least, to a retrogradation of the starch. This retrogradation may account for the greater firmness and lack of sloughing of potatoes that are heated before cooking.

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THE EFFECT OF WET SOIL AND CARBON DIOXIDE ON POTATO CHIP COLOR AND SUGAR CONTENT[1]

L. J. KUSHMAN[2], M. W. HOOVER[3] AND F. L. HAYNES[3]

INTRODUCTION

A large portion of the early potato crop produced in the southern states is made into potato chips. At harvest the early white-skinned varieties such as Sebago, Cobbler, Katahdin and Plymouth usually produce a desirable light golden brown chip and, with moderately warm storage conditions, continue to do so (6). Sometimes potatoes producing light-colored chips at harvest will produce dark undesirable chips after being held a few days.

The variations in chip color at harvest as well as the differences in response of tubers after comparable holding conditions are serious problems for the chip manufacturers. Previous work (8) indicated that soil moisture affected chipping quality of potatoes.

Wet soil reduces aeration, and causes an accumulation of carbon dioxide and a reduction of oxygen in the soil. Previous work has shown that carbon dioxide increases in tubers stored under moist conditions (10) and in those stored at atmospheres high in carbon dioxide (3, 4). Total sugar content increased in tubers subjected to above normal levels of carbon dioxide in storage, although very little change occurred in reducing sugars (1, 5, 11). Miyamoto *et al* (9) reported that tubers subjected to either wet air or 10 per cent carbon dioxide produced dark colored chips.

These studies were undertaken to determine the relation of soil moisture to the carbon dioxide and oxygen content of potatoes and to their quality for chip manufacture; additionally to determine whether high levels of carbon dioxide in storage produce chip color changes observed in potatoes with high carbon dioxide content caused by field conditions.

MATERIALS AND METHODS

Field and Greenhouse Tests. Near the end of the growing season of 1957 six small one-row test plots about 25 feet in length were established in a field of Russet Sebago potatoes in southern Alabama. Through irrigation, dry, wet and saturated soil-moisture levels were maintained. Vines were removed from half the plots when the test was started (9 days before harvest). The dry plots received no irrigation and only small amounts of rainfall during the 9 days before the tubers were harvested. Soil thermometers and Lark soil tensiometers were placed at about tuber depth in several of the plots and read at least twice daily. Soil moisture varied from 26 to 71, 70 to 97 and 88 to 100 per cent of capacity in the dry, wet and saturated plots, respectively. The wide range of soil moisture

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in the dry plots is not indicative of the generally dry conditions that prevailed in these plots because soil moisture was usually low and averaged about 35 per cent of saturation. Soil temperature varied from 72 to 92°F. and averaged about 3° warmer during the day in the dry plots than in the wet and saturated plots.

After 9 days of treatment the potatoes were harvested and a representative sample of tubers from each treatment was made into chips. The remaining tubers were placed at 60°F. and chips made from these after 1 and 2 weeks of storage.

In 1958 a similar test was attempted in a planting of Sebago potatoes at Faison, N. C. Rainfall and failure of irrigation equipment obliterated some of the differences in soil moisture. Samples were collected from the driest and wettest locations in the test. Chips were made at harvest and after holding 1, 2 and 3 weeks at 60°F. The driest location in this instance had been very wet at intervals before harvest.

A greenhouse experiment using the Plymouth variety was set up in 1958. Potatoes were grown in 72 3-gallon cans filled with a sandy soil and punctured at the bottom for drainage. Three weeks before harvesting, the potato plants in these cans were moved into the greenhouse where one-third were given very little water, one-third watered intermittently to maintain slightly less than saturation and one-third placed in about 5 inches of water to produce saturated soil conditions. Because of heavy rains just before the cans were moved to the greenhouse all the cans contained saturated soil at that time. The driest soil conditions varied from 30 to 60 per cent of saturation once the effect of the rain was overcome, but on the average the soil remained moist rather than dry.

After 3 weeks in the greenhouse the tubers were removed from the pots. One sample from each treatment was subjected to a vacuum of about 20 inches for 1 hour while under water. The gases that came off were collected and analyzed for carbon dioxide and oxygen. Other samples were used for making chips and for sugar analysis.

Storage Tests: In 1957 Sebago potatoes were harvested June 8 in Baldwin Co., Alabama, held 3 weeks in air at 60°F. and then divided into 4 groups and held an additional week at 60°F. in atmospheres averaging 0, 25, 70 and 80 per cent carbon dioxide and 20, 23, 21 and 3 per cent oxygen, respectively. Samples of tubers from the various treatments were made into chips, and the remainder held in air at 60°. After 1 and 2 week periods these samples were made into chips.

In 1958 a similar test was conducted. Katahdin potatoes grown at Plymouth, N. C., were harvested July 1 and held 1 week at 60°F. before treatment. Some of the tubers were held an additional week at 60° in atmospheres averaging 0, 10, 31 and 90 per cent carbon dioxide and 20, 23, 22 and less than 1 per cent oxygen, respectively.Additional tubers, originally held for 1 week at 60°, were moved to 70° and held 1 week in atmospheres averaging 0, 10, and 29 per cent carbon dioxide and 20, 22 and 22 per cent oxygen, respectively. All tubers were returned to a normal atmosphere at 60° after the treatment period. Chips were made from tubers of each treatment immediately after treatment and 9, 16 and 23 days later. One sample from each treatment was held in an atmosphere containing more than 90 per cent carbon dioxide and less than 1 per cent oxygen

from the 16th to the 23rd day after the original treatment. Sugar analyses were made of potatoes from each treatment and storage period. A holding temperature of 60° was selected because this is a borderline temperature for holding early potatoes (6).

From 6 to 12 tubers were used in each sample, depending upon the quantity of tubers available in the treatments. Chips were fried in oil at 340 to 350°F. and agitated until bubbling ceased.

Chip samples were scored for color on a scale on which 70 designated a very light golden color, 40 a dark golden color of questionable acceptance and 20 a very dark undesirable color. This corresponds to scores of 4, 7 and 9, respectively, on the chart proposed by Coughlin (22). Sugars were determined by a modification of the Shaffer-Somogyi method in which sucrose was hydrolyzed with invertase (7).

Results

Field and Greenhouse Tests: In 1957 neither soil moisture nor loss of vines affected chip color at harvest (Table 1). However, when potatoes were held at 60°F., differences between treatments developed. Tubers from saturated soil produced darker chips than tubers from dry soil. Wet soil conditions produced an intermediate effect on chip color. Loss of vines caused consistently darker chips at all moisture levels after 2 weeks' storage, but the effects of vine removal on chip color was less than the effect of soil moisture.

Table 1.—*Chip color ratings of Russet Sebago potatoes following 9 days of treatment with different soil-moisture levels and loss of vines, 1957 season.*

Treatment		Chip Color Score after Indicated Number of Days at 60°F.[1]		
Soil Condition	Vine Condition	0[2]	7	14
Dry	Intact	70	65	65
	Removed	70	65	60
Wet	Intact	70	65	60
	Removed	70	60	55
Saturated	Intact	70	60	50
	Removed	70	55	40

[1]A score of 70 indicates a light golden brown color, 40 a dark golden color of questionable salability, and 20 a very dark brown color.
[2]When harvested

In 1958, the driest location in the field test with Sebagos produced tubers that gave chips scoring 69 at harvest, while tubers from the wettest location, gave chips scoring 63. This difference was maintained after 1, 2, and 3 weeks storage at 60°F. but the scores dropped to 41 and 36 respectively by the third week.

Of potatoes grown in the greenhouse, the carbon dioxide content of the tubers at harvest was highest in those from saturated soil and lowest in those from moist soil (Table 2). Although these data on the effect of soil moisture upon the carbon dioxide content of the tubers are not exten-

TABLE 2.—*Gas content, chip color and sugar content of Plymouth potatoes subjected to 3 moisture levels in a greenhouse for 3 weeks before harvest, 1958.*

Soil Condition	Gas per 100 g. after Treatment		Chip Color Score[1]		Reducing Sugar Content[2]		Sucrose Content[3]	
	Carbon Dioxide	Oxygen	At Harvest	After 7 Days at 60°F.	At Harvest	After 7 Days at 60°F.	At Harvest	After 7 Days at 60°F.
	Ml.	Ml.			Per cent	Per cent	Per cent	Per cent
Moist	0.8	1.2	64	28	.074	.276	.106	.223
Wet	1.6	2.3	54	21	.046	.265	.142	.268
Saturated	2.7	1.7	46	23	.085	.286	.364	.255

[1]A score of 70 indicates a light golden brown, 40 a dark golden brown of questionable salability, and 20 a very dark brown color.
[2]Fresh weight basis, as glucose.
[3]Fresh weight basis.

sive, they indicate that wet soil conditions may cause an increase in carbon dioxide content. At harvest, tubers from the saturated soil produced the darkest chips. Reducing sugar content was low in all treatments but total sugar content was highest in the potatoes grown in saturated soil. After 1 week at 60°F. all the tubers produced dark chips and contained more reducing sugars than were present at harvest. Tubers from the wetter soils contained more reducing sugars and produced darker chips.

Storage Tests: In 1957 chip color was similar from all treatments when the tubers were removed from the gas treatments (Table 3). During the 2-week storage period after removal from the gas treatments the tubers held in a normal atmosphere produced chips that varied little in color but those previously held in high levels of carbon dioxide produced chips that were progressively darker. Although the three carbon dioxide atmospheres varied in composition, the effects on chip color were very similar.

TABLE 3.—*Chip color ratings of Sebago potatoes held 7 days in different gas mixtures and then returned to normal atmosphere, 1957.*[1]

Average Gas Concentration During Treatment		Chip Color Score after Indicated Number of Days Following Gas Treatment[2]		
Carbon Dioxide	Oxygen	0	7	14
Per cent	Per cent			
0	20	50	55	55
25	23	55	45	30
70	21	55	45	30
80	3	55	50	25

[1]Tubers held 3 weeks at 60°F. before starting the test and held at 60° during the test.
[2]A score of 70 indicates a light golden brown, 40 a dark golden brown of questionable salability and 20 a very dark brown color.

In 1958 differences in color of chips were not great immediately after treatment (Table 4), but after 9 and 16 days at 60°F. the tubers treated with carbon dioxide produced much darker chips than did tubers held in normal atmosphere. The amount of darkening roughly paralleled the amount of carbon dioxide surrounding the tubers during treatment. From the 16th to 23rd day after treatment chip color improved in some lots when the tubers remained in normal air. The chip color became darker or changed very little when the tubers were held from the 16th to 23rd day in an atmosphere containing a very high level of carbon dioxide and very low level of oxygen.

TABLE 4.—*Chip color ratings of Katahdin potatoes given different gas and temperature treatments in storage, 1958.*

Treatment[1]			Chip Color before Treatment	Chip Color Score after Indicated Number of Days at 60°F. Following Gas Treatments[2]				
Temp.	Average Gas Concentration							
	Carbon Dioxide	Oxygen		0	9	16	23	16+7[3]
°F.	Per cent	Per cent						
60	0	20	55	47	43	50	46	40
60	10	23	55	47	40	35	37	19
60	31	22	55	40	15	20	20	16
60	90	[4]	55	55	10	10	25	9
70	0	20	55	47	32	40	35	37
70	10	22	55	47	32	30	41	34
70	29	22	55	47	25	25	32	30

[1]Tubers held 7 days at 60°F. before starting treatments which were of 7 days duration.
[2]A score of 70 indicates a very light golden color; 40 a dark golden color of questionable salability and smaller scores indicate progressively darker color.
[3]Last 7 days tubers held in an atmosphere containing more than 90 per cent carbon dioxide and less than 1 per cent oxygen.
[4]Less than 1 per cent.

Reducing sugar contents of the tubers very closely paralleled the chip color changes (Tables 4 and 5). A correlation coefficient of —.88 was obtained, indicating a highly significant inverse correlation between reducing sugar contents and chip color scores.

Modified atmospheres produced variable effects on the sucrose content of the tubers (Table 6). In some instances modified atmospheres increased sucrose while decreasing it in others during treatment. After treatment most tubers held in modified atmospheres increased in sucrose content above that in tubers held in a normal atmosphere.

Discussion and Summary

The data indicate that high soil moisture caused changes in potatoes which influenced the color of chips made from them. The poor color of chips made from potatoes grown under high soil moisture was always apparent after storage at 60°F. and sometimes also immediately after harvest. The effect of high soil moisture levels on chip color may have been due to the accumulation of carbon dioxide in the tubers, as holding potatoes in an atmosphere of carbon dioxide produced similar effects on chip color.

TABLE 5.—*Reducing sugar content of Katahdin potatoes given different gas and temperature treatments in storage, 1958.*

Treatment[1]			Reducing Sugar Content after Indicated Number of Days at 60°F. Following Gas Treatments[2]				
Temp.	Average Gas Concentration						
	Carbon Dioxide	Oxygen	0	9	16	23	16+7[3]
°F.	Per cent	Per cent					
60	0	20	.145	.176	.127	.117	.146
60	10	23	.148	.221	.245	.146	.209
60	31	22	.178	.337	.260	.288	.337
60	90	[4]	.111	.374	.380	.288	.499
70	0	20	.139	.221	.172	.236	.111
70	10	22	.135	.190	.208	.156	.182
70	29	22	.130	.353	.279	.199	.289

[1]Tubers held 7 days at 60°F. before starting treatments which were of 7 days duration.
[2]Fresh weight basis, expressed as glucose.
[3]Last 7 days tubers held in an atmosphere containing more than 90 per cent carbon dioxide and less than 1 per cent oxygen.
[4]Less than 1 per cent.

TABLE 6.—*Non-reducing sugar content of Katahdin potatoes given different gas and temperature treatments in storage, 1958.*

Treatment[1]			Sucrose Content after Indicated Number of Days at 60°F. Following Gas Treatments[2]				
Temp.	Average Gas Concentration						
	Carbon Dioxide	Oxygen	0	9	16	23	16+7[3]
°F.	per cent	per cent					
60	0	20	.212	.177	.127	.161	.116
60	10	23	.203	.248	.226	.146	.176
60	31	22	.267	.396	.266	.255	.197
60	90	[4]	.082	.262	.204	.205	.161
70	0	20	.240	.158	.150	.162	.166
70	10	22	.171	.114	.180	.137	.124
70	29	22	.295	.263	.345	.223	.197

[1]Tubers harvested July 1, 1958 and held 7 days at 60°F. before starting treatments. Treatment period 7 days.
[2]Fresh weight basis.
[3]Last 7 days tubers held in an atmosphere containing more than 90 per cent carbon dioxide and less than 1 per cent oxygen.
[4]Less than 1 per cent.

The reducing sugar and sucrose contents immediately after treatment with gas mixtures were not indicative of the changes that occurred after treatment. Therefore, it does not appear that sugar content or chip color of the tubers immediately after treatment with modified atmospheres can be used to predict subsequent changes in sugar content and chip color.

The importance of maintaining sufficient moisture for good growth and high yields is obvious. Based on the preliminary results of this study, it appears possible that potatoes that have been subjected to excessively

wet soil conditions before harvesting may produce poorly colored chips. However, in order to better understand the effects and relationships between soil moisture conditions and chip color, more data are needed. Through selection of soil type and provision for drainage some measure of control over soil moisture is possible even in periods of heavy rainfall. In recent years irrigation of potato fields has increased. More care may be needed to prevent over-irrigation prior to harvesting potatoes intended for chip manufacturers.

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THE LONG RANGE PROGRAM OF THE INTER REGIONAL POTATO INTRODUCTION AND PRESERVATION PROJECT (IR-1): A POLICY STATEMENT[1]

The functions of the Inter-Regional Potato Introduction and Preservation Project (IR-1) are the same as those of the regional plant introduction projects except that the IR-1 Project is limited to one crop, the potato. The formulation of a long range program for the introduction and preservation of a single crop is obviously a much simpler task than that of formulating a similar program for the many crops embraced by the regional projects. The thoughts expressed in the following discussion encompass the ideas of the past and present members of the IR-1 Technical Committee and deal with the objectives and basic procedures as well as the philosophy or reasons for these procedures.

The policy statement of the IR-1 Project will be presented under four main headings: 1) Collecting, 2) Propagation and Preservation, 3) Cataloging and 4) Utilization.

COLLECTING

Total genetic variation and basis of selection: The potentially valuable germ plasm in the potato is represented by the genetic variation found within and between the 200 (more or less) wild and cultivated tuber-bearing species of *Solanum*. The exceptional characters that make clones useful for economic purposes may be either common to all variants of a species or more often limited to particular variants within a species. Clones with exceptional characters of a type that appear to be useful for either economic purposes or for research studies may be designated as exceptional clones. They represent the potentially valuable germ plasm.

Cultivated Species: In cultivated species, the exceptional clones can be located through perusal of the literature and through contacts with workers engaged in potato improvement throughout the world. A liberal interpretation can be made on what constitutes an exceptional clone without danger of having the number become excessive. This is in sharp contrast to collecting all the introduced varieties of a species. These varieties differ from each other for the most part in the particular combination of exceptional characters. Thus, 20 exceptional characters could be represented by 20 clones .These could be combined into more than a million distinct varietal combinations. This duplication of exceptional characters in collections of varieties in addition to the fact that they represent only a small number of the exceptional characters to be found in the working collections of breeders makes them inefficient and inadequate as a means of collecting and maintaining the potentially useful germ plasm of a cultivated species. A collection based on exceptional clones would contain many introduced

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Most of this manuscript was prepared by the late Dr. F. A. Krantz, Department of Horticulture, University of Minnesota, St. Paul, Minn. Dr. Krantz was the first chairman of the IR-1 Technical Committee and served in this capacity from 1950 until his death in 1958.

and non-introduced clones as well as numerous species of hybrids in various stages of development.

Wild and Semi-cultivated Species: The collecting of exceptional clones in wild and semi-cultivated species, due to limited information concerning them, presents a different problem. Many, if not most of the South American species have been named and described from samples inadequate for the purpose of defining the limits of the species, of studying their botanical and cytogenetic relationship and their economic potentialities. For the latter purpose, samples representing different ecologic habitats would be of major importance. It is probable that sampling for the purpose of describing and defining the limits of a species would include these ecologic samples. In addition to the species and their variants growing in their native habitats, there are samples and clones in existing collections that have received considerable study. The available information on these samples makes them valuable for further study and for inclusion in a breeding program. These and their species hybrids could be subjected to the same type of selectivity as suggested above for variants of a cultivated species.

Special Collections: Collections made for the purpose of exploring to locate a source of material containing a new character such as resistance to a disease or an insect or for some special economic character are in a different category from those discussed above. They would be made upon the request of some individual or group of individuals interested in exploring for a new character. The maintainence of the clones would be expected to be temporary except for those in which exceptional characters were found.

Propagation and Preservation

A program of germ-plasm preservation in asexually propagated plants, such as the potato, may be accomplished through both sexual and vegetative propagation. Several factors must be considered in determining which mode of propagation is best suited to the maintenance of germ plasm. In the potato and related *Solanum* species, preservation of germ plasm through asexual propagation is laborious and costly as compared with sexual propagation. The tuber-bearing *Solanum* species must be grown annually in a program of asexual preservation; in a program of sexual preservation, these species must be grown only once in an 8-10 year period. The loss of stocks through disease, especially the virus diseases, is a constant threat in vegetative propagation. This hazard is strikingly reduced by sexual propagation since none of the viruses attacking the potato has been found to be seed-transmitted. The volume of refrigerated storage required in a program of asexual maintenance of potato germ plasm (*i.e.* storage of potato tubers) is vastly greater than the refrigerated storage required in a program of sexual maintenance (*i.e.* storage of true seed). Since the potato is highly heterozygous, it has seemed advisable to maintain the exact genotype of some of the highly-selected, elite clones (*i.e.* advanced breeding selections and certain varieties). Consequently, such clones, as well as certain male sterile clones, are preserved through asexual propagation. Hence, in the potato, the preservation of germ plasm involves both sexual and asexual propagation.

Cataloging

Thorough cataloging with extensive cross-indexing of the material and its known characters is essential. The cataloging would not include identifying descriptions of either the species or their variants, though it may contain references to this literature. It should supply information pertinent to men engaged in the improvement of the crop, and to students interested in making research studies on the material. It would be desirable to have it in a form as convenient for shelf filing as a book. The technical aspects of preparing a catalog, its periodic revision to include new materials and information, and its distribution to actual and potential workers in the field of research and improvement of the crop, deserve careful study. It is desired to emphasize the necessity of cataloging the material, along with the pertinent information on its potentialities for breeding and research, if the collection is to attain the contemplated usefulness.

Utilization

One of the important functions of the IR-1 committee is to promote and encourage the use of the collection for research and improvement of the crop. One aspect of this, the cataloging of the material for potential workers, has been discussed. Another essential to make the collection useful is a thorough classification of the species in the genus *Solanum*, section *Tuberarium*. This will require a large amount of exploration and research. It calls for specialized training in a field of research somewhat outside the scope covered by the Agricultural Experiment Stations.

The cytogenetic problems involved in the use of the various species in breeding offer a large field for present and future study. It is a field which has considerable appeal to students specializing in plant science. Processing the material to make F_1, F_2, and BC_1, generations available for immediate study may greatly enhance its value for use by these students. This is a very large field for research which will be done in segments by full and part time workers covering an extended period of time, coeval with the breeding of the crop.

Study and utilization of the economic potentialities of the collection is expected to be a continuous process by men engaged in potato improvement. The process has been going on for many years. Varieties derived from species hybrids have been introduced, and in the not too far distant future, most varieties are expected to be derived from species hybrids. Potato breeding is still in its infancy. Even the known potentials in *S. tuberosum* have barely been touched. The use of wide crosses involving species hybrids as a source of heterosis is part of the basic philosophy back of the breeding methods of clonally propagated crops. Hence the collection is expected to be utilized to the fullest extent commensurate with the extent of personnel and facilities available for the improvement of the crop. It is intended to be a reservoir of germ plasm which will insure the continuous improvement of the crop into the unforseeable future. One of the logical functions of the IR-1 project is to do everything possible to facilitate the use of the material in the collection.

Resolution

The following resolution was prepared at the 1958 annual meeting of the IR-1 Technical Committee:

"The potato breeding fraternity of the world has suffered the loss of a truly outstanding member through the death of Dr. F. A. Krantz. His leadership in potato research has been established by his scientific writings. Dr. Krantz's influence extends far beyong his scientific achievements. An outstanding exemplification of his leadership, outside of Minnesota, has been his dominant role in the initiation and sustained guidance of the Inter-Regional Potato Introduction (IR-1) Project.

As chairman of the IR-1 Committee, Dr. Krantz's wisdom, judgement and patience were instrumental in mapping the course of the project through its uncharted formative years. We of the IR-1 Technical Committee deem it an honor to have known Dr. Krantz as a scientist, a leader and a personal friend."

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Columbia-Southern Chemical Corporation has announced the temporary appointment of Dr. Richard L. Sawyer of Cornell University as a consultant for the firm's program on the development and application of Chloro IPC for sprout inhibition of potatoes.

An associate professor in the Department of Vegetable Crops at Cornell's Long Island Vegetable Research Farm, Dr. Sawyer has gained nationwide recognition for his broad experience in conducting his program on potato sprout control at Cornell. In his new capacity with Columbia-Southern, Dr. Sawyer will be associated with experimental and extension workers of the states developing the application of Chloro IPC under storage conditions which are peculiar to each of the different potato producing areas. Dr. Sawyer will take a six-month leave of absence from Cornell effective December 1, according to the firm.

Dr. Sawyer has authored numerous research articles on potato physiology and, in 1947, received the Leonard H. Vaughan Award for "Vaporized Chemical Inhibitors and Insulation—Two New Methods of Sprout Control for Tuber and Bulb Crops."

Dr. Sawyer was graduated from the University of Maine with a Bachelor of Science degree and earned a Ph.D. degree at Cornell where he has served on the faculty since 1953. He is secretary of the Potato Association of America and a member of the American Society of Horticultural Science and American Society of Physiologists.

INTERNATIONAL POTATO RESEARCH PROJECTS

The titles of some important foreign potato research projects were not submitted to Dr. Larson last year for publication in the American Potato Journal. We would like to have this list of projects as complete as possible so that our members will know what research projects are underway throughout the world and who is conducting them. We will publish the titles of the projects not included in the first listing if the number received warrants it. Please send, as soon as possible, the titles of the projects, the particular problems involved, the names of the research workers involved and the name and address of the institute, university or other agency responsible for the research, to Dr. Russell Larson, Department of Plant Pathology, University of Wisconsin, Madison, Wisconsin.

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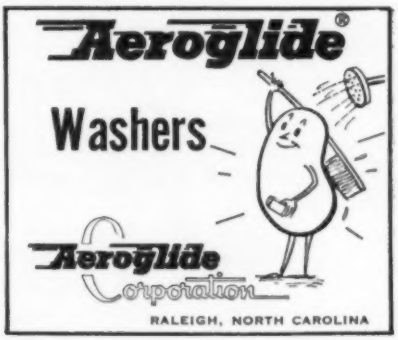

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North American Potato Varieties

By H. M. Darling[1]

PROPER IDENTITY of the many potato varieties being grown particularly for seed purposes in North America today is becoming an increasingly complex one. The magnitude of the problem is emphasized by the fact that a record volume in excess of 70 million bushels of certified seed was produced in the United States and Canada in 1957. Although 95 per cent of this volume is represented by 10 varieties, over 70 varieties are included in the remaining 5 per cent. Certain states currently certify as many as 40 varieties.[3]

At the present time there is no single publication available for reference in which all of our present varieties are described. Clark and Lombard[11] published rather complete descriptions of several American varieties in 1946 and this paper represents one of the most significant contributions on this subject to date. One cannot, however, discount several earlier publications, particularly those by Stuart.[59,60] From these studies it is quite obvious that care must be exercised in selecting those vegetative or morphological characteristics that remain reasonably stable or constant under a wide range of environmental conditions. For example, extreme fluctuations of moisture, temperature and light duration and intensity are known to influence growth habit, intensity of pigmentation, leaf color and type and tuber shape in many different ways. Changes in growth habit as the growing season progresses are also influenced by age of the plant and fertility of the soil. Familiarity with these responses on the part of seedsmen and inspectors is essential in the production and maintenance of seed stocks and in the elimination of mixtures.

FIRST CERTIFICATION AGENCY

In the use of variety names on official certification tags, seed growers lists, etc., by certification agencies, it is the present established policy to use only the official name designated by the breeder. This practice avoids many common names, trade names or synonyms by which the seed consumer might be confused in ordering the variety he wants for his needs. Such was not always the case, however, for the use of several synonyms for the same variety was commonly practiced in early 1900. The abuses associated with this practice along with emphasis on disease control by inspection and certification were actually the reasons for organizing the first state certification agency in 1913.

The variety picture is constantly changing and will continue to change because several breeding programs are currently releasing varieties superior in at least one characteristic to our present standard varieties. The summary descriptions included in the present listing follow original published releases

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[1]Professor of Plant Pathology, In Charge Potato Certification, Department of Plant Pathology, University of Wisconsin. The cooperation of the following members of the Certification Committee of the Potato Association is gratefully acknowledged: J. W. Scannell, Karl Fernow, R. C. Hastings and T. H. Hankins.

whenever possible; detailed descriptions will be found in the literature citation accompanying each variety. It is hoped that the present alphabetical listing will serve as a ready reference and guide for inspectors, research workers, growers and others interested in maintaining our varieties in name and identity as designated by the breeder.

RECORD REPORTING IN 1957

The estimated 34,378,005 hundredweight of certified seed produced in the United States in 1957 is the largest crop ever to be reported by certifying agencies in 27 states.[3] Forty-two per cent of this volume is represented by Katahdin which has now led all other varieties for the eleventh consecutive year. Russet Burbank continued in second place followed by Red Pontiac and Cobbler. Next in order, among the 10 top ranking varieties were Kennebec, White Rose, Chippewa and Red LaSoda—all showing increases over 1956; and Cherokee and Sebago—both with smaller production. The rank of each of the 20 remaining varieties is indicated in the text. All agencies reported on a total of 54 varieties, but did not list the names of several others placed in an "unclassified" category because of little volume. The certification report[3] also shows that the average yield of certified seed was 221 sacks (368 bushels) an acre for 1957 compared to 186 sacks (310 bushels) for the years 1946 to 1955. On the other hand the average yield of potatoes grown in the United States for all purposes in 1957 amounted to 169 sacks (281 bushels) an acre and 150 sacks (250 bushels) an acre for the years 1949 to 1955. Furthermore, the total volume of certified seed indicated above would actually plant about twice the acreage being grown for table use.

Canada produced approximately 8 million hundredweight (over 13 million bushels) of certified seed in 1957 in nine provinces, 98 per cent of this production being concentrated in Prince Edward Island and New Brunswick. Thirty-seven varieties were certified of which the following seven, in the order given, make up 94 per cent of the volume: Sebago, Katahdin, Kennebec, Irish Cobbler, Netted Gem (Russet Burbank), Green Mountain and Red Pontiac. Canada has a licensing system that prevents the hasty introduction of new varieties until such a time as they have proven their value and there appears to be a reasonable market. At present, 51 varieties appear on this list. The average estimated yield of certified seed in 1957 was 161 hundredweight (about 270 bushels) compared to 135 hundredweight (225 bushels) for potatoes grown for all purposes.

LATE BLIGHT RESISTANCE

In recent years considerable emphasis has been placed on breeding varieties resistant to late blight and on studies of the variability of the pathogen due to physiologic specialization. As a result of this research, thirty-three varieties have been released which possess varying degrees of resistance to late blight. The following varieties are reported to have "major" or dominant gene resistance derived from the wild Mexican species, *Solanum demissum*, or from the German "W"-race selections derived from *S. demissum-S. tuberosum* hybrids: GROUP 1—(*S. demissum* pedigree) Ashworth, Chenango, Cortland, Empire, Essex, Fillmore, Glenmeer, Harford, Madison, Placid, Snowdrift and Virgil. GROUP 2—("W"-race pedigree) Boone, Canso, Cherokee, Delus, Kennebec, Keswick, Merrimack, Plymouth, Pungo, Saco and Tawa. These varieties are apparently immune from the common race and some other races of late blight but are very susceptible to certain other races. It is also possible that the above

varieties may possess a level of polygenic resistance. The following varieties have no dominant genes for resistance to blight, that is, they carry no "major" genes from either *S. demissum* or "W"-race sources: Calrose, Cayuga, Menominee, Ontario, Onaway, Potomac, Saranac, Sebago, Seneca and Sequoia. This group possesses some resistance to all physiologic races of blight but no immunity to any specific race. This type of resistance is commonly referred to as "minor" gene or multi- or polygenic resistance or field resistance. In the text of this paper the varieties possessing resistance of any type are referred to as "blight resistant".

Antigo[50]

Developed and released in Wisconsin in 1954. Menominee x Wis. seedling 302.44-6.

Medium maturing with open, semi-upright growth habit. White blossom. Tubers smooth, white, uniform in size, with tough skin. Average yielding ability, total solids similar to Katahdin. Tubers inclined to be somewhat irregular under adverse growing conditions.

Resistant to scab. Susceptible to internal necrosis.

Arran Victory[51]

Arose from an open pollinated flower on a potato plant of unknown origin found in a garden in Granton, England. This seedling was developed by a Mr. MacKelvie in 1912, and named and introduced by him in 1918.

Arran Victory is grown to a considerable extent by farmers and gardeners in the province of Newfoundland, Canada. It is considered by them as a variety with superior cooking quality to other varieties grown in that province.

Vines tall, upright, open and usually vigorous. Stem hard, wing crinkled slightly. Leaves open, drooping, widely spaced, slight overlapping, flat and of a dark gray-green color. Flowers white. Tubers round to oval in shape with a smooth dilute purple colored skin. Flesh pale yellow. Maturity late. Cooking quality considered to be good.

This variety appears to have considerable resistance to both leaf roll and mosaic, also to late blight.

Ashworth[46]

Developed in New York and released in 1946. Originated from a cross of two New York seedlings each with *S. demissum* in parentage.

Medium maturity. Short spreading plants with thick green to pale vinaceous stems, large open dark green leaves, white blossoms with pale lavender shield. Tubers are roundish with buff skin, few eyes, deep at bud end of large tubers, white flesh. Total solids equal to or better than Katahdin.

Resistant to late blight. Susceptible to leaf roll.

Beauty of Hebron[11]

Claimed to have been originated by E. L. Coy in New York State about 1878 as a seedling of Garnet Chili.

Plants large and spreading with white blossoms. Tubers are long, distinctly flattened, and creamy white with areas of light pink.

Blue Christy[11]

Origin unknown.

Produces long purplish tubers, usually distinctly flattened at basal end. High baking quality.

Blue Victor[11]

Origin unknown. Apparently a sport of Peerless.

Plants medium in size, spreading with medium thick, prominently angled, slightly pigmented stems. Leaves of medium length and breadth, open type, green. White blossom. Medium sized, ovate to heart shaped, flattened, heavily shouldered tubers with flaked to somewhat netted skin that has few, many or no purple splashes around the eyes. Shallow to deep eyes with prominent eyebrows, white flesh.

Blue Victor is of little commercial importance and of no breeding value.

Boone[22]

Developed by U.S.D.A., released in North Carolina in 1955. Cross between Cornell seedling TI-5 and USDA seedling B231-3, both having late blight resistance.

Late maturing variety with erect or upright vine growth and medium thick, prominently angled, reddish purple pigmented stems. Large, closed, green leaves. White blossom. Medium oblong and medium thick tubers with smooth, creamy buff skin, shallow eyes and white flesh. Excellent cooking and eating qualities except for baking.

Resistant to late blight.

Brown Beauty[11]

Synonyms: Bresee's No. 2, Barkleys Prolific and Prolific. Developed by Albert Bresee in Vermont in 1861. Claimed to be a seedling of Garnet Chili from the same seed ball as Early Rose.

Large, spreading to decumbent plants with somewhat zigzag, slightly pigmented, medium thick stems and medium length, narrow, open type leaves. White blossom. Medium sized, oblong, flattened tubers with smooth, white skin and pink, shallow eyes, white flesh.

No longer of commercial importance. Some certified seed grown in Colorado in 1949.

Susceptible to wart.

Burbank[11]

Synonym: Burbank's seedling. Originated by Luther Burbank and claimed to be a seedling of Early Rose. Introduced in 1876.

Medium sized spreading plants with slight reddish purple pigmented, medium thick stems and long, medium in breadth and type, green leaves. White blossom. Tubers long, cylindrical, slightly flattened and a *smooth, white* skin with numerous, shallow eyes, white flesh. Grown mostly in Oregon.

Susceptible to most of the common potato diseases.

Calrose[10]

Developed by U.S.D.A., released in 1946. Origin: Ackersegen x Katahdin.

Late maturing, large spreading plants with medium thick, slightly pigmented stems prominently angled. Leaves long, medium in breadth. Pale lilac colored blossoms. Tubers are long, with smooth, tough, white skin and shallow eyes, cream colored flesh. High yielding variety adapted to California.

Resistant to late blight. Susceptible to *Fusarium oxysporum.*

Canoga[32]

Developed in New York, released in 1951. Origin: (Katahdin x Albion) x Katahdin.

Medium late maturing. Plants medium in size, spreading, with medium thick green stems. Leaves medium in length and width, medium green. White blossom. Tubers are round, medium thick, shallow eyes, flaked skin, white flesh. Keeps type well. Good cooking quality.

Resistant to leaf hoppers and tarnished plant bug. Susceptible to leaf roll.

Canso[1]

Developed by the Dominion Experimental Station, Fredericton, New Brunswick. Origin: *Solanum demissum* x Earlaine x Katahdin x Katahdin x Katahdin x Katahdin. Ranks 11th in certified seed production in Canada.

Late maturity. Plants medium in size, spreading; stems thick and slightly angled, green. Medium length leaves, midrib green, scantily pubescent. Lilac blossom. Short elliptical medium thick tubers with shallow eyes. Dark cream skin color. Under New Brunswick conditions is fully equal to Katahdin in yielding ability. Cooking quality is equal to Green Mountain. Tubers susceptible to hollow heart under certain growth conditions.

Susceptible to leaf roll and bunch top viruses. Expresses symptoms very clearly. Resistant to the common race of late blight.

Canus[55]

Developed by U.S.D.A., released from Alberta, Canada, in 1949. It is USDA seedling 41914 which was a cross Greeley seedling No. 9-11 x USDA 24642.

Medium early maturity with medium size, spreading vines, with medium thick prominently angled, reddish purple pigmented stems. Medium to long leaves, medium green. Light purple or lilac blossom color. Tubers are roundish-oblong, somewhat flattened, few eyes, shallow; smooth creamy colored skin with white flesh. Bakes very well and boils dry and mealy.

Resistance to disease not reported.

Cayuga[9]

Developed by U.S.D.A. and released in New York in 1946. Origin: Hindenburg x Katahdin.

Medium late maturity with spreading medium sized plants becoming prostrate at maturity. Slender green stems. Flowers white with pale bluish lavender color. Tubers flattened, egg-shaped with shallow eyes, russeted or scaly skin, white flesh. High specific gravity, good quality; light tuber set, all may not reach market size under unfavorable conditions.

Resistant to scab and late blight. Tolerance to *Fusarium solani* var. *eumartii*.

Charles Downing[11]

Synonyms: Idaho Rural, Earliest of All. Parentage unknown. Developed by O. H. Alexander in Vermont. Introduced in 1887.

Large, spreading plants with medium thick, slightly reddish purple pigmented to green mottled stems and green leaves that are medium in length, breadth and type. White blossom. Tubers medium in size, oblong to ovate with smooth white skin, medium deep eyes and white flesh. Carries one of the genetic factors for red tuber color, complimentary to the one carried by Katahdin.

Immune from wart disease.

Chenango[46]

Developed at New York, released in 1946. Cross between two seedlings 1097 (USDA 46110) x N.Y. BXS/1, the latter seedling having *Solanum demissum* in parentage.

Early maturing. Weak green stalks become prostrate as season progresses, develops abundant axillary shoots. Leaves are large, short, open, light green. White blossom. Tubers round, thick, with shallow eyes and cream colored skin. White flesh. Tendency to set heavy.

Resistant to late blight. Susceptible to leaf roll and virus Y (rugose).

Cherokee[48]

Developed by U.S.D.A. and released in Iowa in 1954. Cross of two USDA seedlings 96-56 x 528-170. Ranks 9th in certified seed production, grown mostly in Maine, Minnesota, Michigan; 12th in Canada.

Medium early maturity. Medium sized, spreading plants with thin slightly reddish purple pigmented stems. Leaves medium to large sized. White blossom. Tubers short, elliptical, somewhat flattened area on one side toward stem end, medium shallow eyes and white flesh. Skin slightly flaked, white (ivory yellow). Total solids compares with Katahdin and Cobbler. High yield.

Resistant to common scab, late blight, mild mosaic and net necrosis.

Chippewa[12]

Developed and released by U.S.D.A. in 1933. USDA 40568 x USDA 24642. Same parentage as Katahdin. Ranks 7th in certified seed production, grown mostly in Maine, Wisconsin, New York; 14th in Canada.

Medium maturity. Plants medium to large, spreading, with thick to medium prominently angled, reddish purple stems. Leaves long, broad. Terminal leaflets frequently acutely lobed. Light lilac colored blossoms. Elliptical to oblong, medium thick tubers with shallow eyes and white skin and flesh. Good yielder; cooks white.

Resistant to mild mosaic. Susceptible to leaf roll and spindle tuber and wart.

Chisago[30]

Developed and released in Minnesota in 1949. Seedling Minn. (13-1) x Cobbler.

Early maturity. Plants medium to large and erect to spreading vines with thick, slightly pigmented stems, medium sized leaves, green, medium type. White blossom. Tubers large, oblong to round, shallow eyes. White skin and flesh. Produces uniformly round, smooth tubers with shallow eyes, few small tubers. Very good cooking quality.

Columbia Russet[33]

Developed by William Scott, a grower in British Columbia, Canada. Seedling from Wee McGregor variety. Introduced in 1937.

Medium maturity. Slightly earlier than Green Mountain. The growth habits, stems and white blossom color all resemble the Green Mountain variety. The leaves are smaller and with fewer blossoms. Tubers have a thick russet, light brown skin, sometimes with a shallow uneven netting and with shallow eyes. White flesh. Yields and stores well.

Susceptible to all common potato diseases.

Cortland[47]

Developed in New York and released in 1947. Result of three backcrosses: *S. demissum* used as male parent in the first cross. Russet Rural was the female parent. A Minnesota seedling was used to secure the backcross, Katahdin for the second backcross and Menominee for the third backcross.

Late maturity. Indeterminate growth similar to Russet Rural, with dense axillary shoots. Tubers very white, smooth, slightly pointed. Drought tolerant.

Resistant to late blight. Susceptible to leaf roll, rugose mosaic and scab.

Cowhorn[11]

Unknown origin.

Plants large, somewhat spreading with white flowers. The tubers are long, curved, cylindrical and pointed and have purple skin. Excellent baking quality.

Dakota Red[11]

Synonym: Jersey Red skin. Originated by O. H. Alexander from Pringles Hybridized seed in Vermont, introduced in 1883.

Late maturity. Plants large, erect, with thick, reddish purple pigmented stems with very long, dark green leaves, medium in breadth and type. Violet blossom. Medium sized tubers, elongate, somewhat flattened with smooth or often flaked, red skin and shallow eyes. White flesh.

Tolerant to hot weather.

Dazoc[63]

Developed and released in Nebraska in 1953. Triumph x Neb. 49.40-3. Sib of Sheridan. Ranks 19th in certified seed production, grown mostly in Nebraska, Minnesota, Wyoming.

Very early maturity. Small, medium compact plants with medium thick, erect stems. Medium to small, open, dark green, glossy leaves. Medium heliotrope blossom color. Medium size, oblong ovate and thick tubers with medium to deep eyes. Dark, bright red, generally glossy, smooth skin. White flesh. Medium specific gravity—greater than Red Pontiac. Tuber type among best of early red varieties.

No known disease resistance and apparently highly susceptible to late blight tuber rot.

Delus[56]

Developed by U.S.D.A and released in Delaware in 1954. Mohawk x USDA 96-56.

Late maturity. Plants medium to large, spreading. Stems thick, green, prominently angled. Medium long, closed, green leaves. Medium lilac blossom color. Short, roundish, medium thick tubers with shallow eyes. Smooth

white skin and white flesh. Very good cooking quality.

Resistant to late blight, slightly more common scab tolerance than Cobbler or Katahdin. May develop mahogany browning at low storage temperatures (34°-38° F.).

DeSoto[34]

Developed and released in Louisiana in 1948. Triumph x Katahdin.

Medium early maturity. Plants are vigorous and upright with small leaves similar to Triumph. Purple blossom. Round to slightly oblong tubers with medium to shallow eyes, red to pinkish-red skin, white flesh.

Resistant to mild mosaic.

Earlaine[15]

Developed and released by U.S.D.A. in 1938. Irish Cobbler x USDA 43055.

Early maturity. Medium size plants, somewhat spreading with medium thick, prominently angled, green stems. Leaves medium in length and width. White blossom. Tubers roundish, thick, with slightly flaked, ivory-yellow skin and shallow to medium shallow eyes. White flesh.

Resistant to mild mosaic.

Earlaine No. 2[11]

Unknown origin. Started from tubers taken from breeding plots at Aroostock Farms, Maine, by a visiting grower.

It is similar to Earlaine except that plants are larger and later in maturity. The tubers are round and white. Inferior table quality.

Early Epicure[51]

Originated and developed by Mr. J. Clark, Christchurch, Hants, England, from a cross of Magnum Bonum x Early Regent. The variety was introduced by Messrs. Sutton and Sons in 1897.

Early Epicure is grown to a limited extent in Canada, mainly in the province of British Columbia as a first early.

Vines tall, upright, strong stems, developing reddish color, becoming very highly colored if much exposed. Leaves rather short, close, drooping. Leaflets narrow, pointed, dark green and glossy, the last pair having waved margins and pointing forward to overlap the terminal which droops. Secondary leaflets fairly numerous. Flower white, not blooming freely. Maturity early. Tuber round, irregular. Skin white but turning pink on exposure to light. Eyes deep, ridged, with raised eyebrows. Flesh white. Sprouts pink. Cooking quality fair to medium.

This variety is susceptible to blackleg, leaf roll and virus Y. It appears to be field immune from viruses A and X.

Early Gem[57]

Developed by U.S.D.A. and released in Idaho and North Dakota in 1955. Russet Burbank x USDA 96-56. Ranks 16th in certified seed production, grown mostly in North Dakota, Wisconsin, Nebraska.

Early maturity. Plants medium to small, spreading, with medium thick stems without pigment and medium-sized, closed, green leaves. White blossom. Medium long to long tubers, medium thick, with shallow eyes. Light to medium heavy russet skin and white flesh. Long rest period. Stores well. Tendency to develop growth cracks with abundant moisture.

Resistant to common scab. Apparently susceptible to all other common potato diseases.

Early Ohio[11]

Originated by Alfred Reese in 1871 and claimed to be a seedling of Early Rose. Ranks 23rd in certified seed production, grown mostly in Minnesota, North Dakota.

Medium to large, spreading plants with thick, medium reddish purple pigmented stems and medium long, wide, open type, green leaves. White blossom. Round-oblong, somewhat cylindrical tubers with smooth, pink skin and numerous, medium deep eyes and white flesh sometimes with color in cortex.

Susceptible to most common potato diseases.

Early Rose[11]

Originated by Albert Bresee in Vermont in 1861 and is claimed to be a seedling of Garnet Chili.

Large, spreading plants with thick, mottled, reddish purple pigmented stems and long, medium in breadth, open type, dark green leaves. White blossom. Tubers oblong, flattish at center with smooth or sometimes flaky, pink skin and shallow eyes. White flesh sometimes streaked with red.

Susceptible to most common potato diseases.

Empire[45]

Developed in New York and released in 1945. (N.Y. AZK-3 x "No. 9" (Rural New Yorker No. 2) Seedling has *Solanum demissum* in parentage.)

Very late maturity. Plants emerge weak and spindly becoming tall and semi-erect, then dense because of axillary growth. Leaves strongly rugose. Stems pale green, thick, not colored. Lavender tint in blossoms. Buff, flaky skinned tubers with white flesh and shallow eyes.

Resistant to late blight.

Erie[8]

Developed by U.S.D.A. and released in Ohio in 1945. USDA 45146 x Earlaine.

Medium late maturity. Plants have general appearance of Green Mountain. Leaves and stems light green, no pigment. White blossom. Tubers are spherical with moderately deep and fairly numerous eyes. White skin and flesh. Cooks white.

No apparent resistance to virus diseases or common scab. Susceptible to leaf hoppers and flea beetles.

Essex[47]

Developed in New York and released in 1947. N.Y. ABX/6 x 1152 (F_2 Triumph). Essex and Glenmeer are sister seedling or sibs. (Female parent has *Solanum demissum* in parentage.)

Late maturing. Erect growth with sturdy green stems and dark green open leaves. Skin is buff colored. Tubers oval with blunt ends, eyes moderately deep, white flesh. Blossoms with wine colored tint. Tendency to produce knobby tubers and large set.

Resistant to late blight. Susceptible to leaf roll and virus Y.

Excel[63]

Developed and released in Nebraska in 1957 as seedling 82.49-1X. From Nebraska 143.47-16 x Neb. 59.41-P1.

Medium to late maturity. Large, medium erect to spreading plants with stiff stems. Medium to large, medium compact and medium to dark green leaves. Pale red blossom color. Oblong, flat tubers with medium deep eyes. Medium to light pinkish, smooth, usually bright skin color. Exceptionally white flesh. High specific gravity. Fair to poor for chipping.

No known disease resistance, slightly higher scab tolerance than Red Pontiac.

Fillmore[47]

Developed in New York and released in 1947. N.Y. AZK-3 x No. 9 (Rural New Yorker No. 2). (Seedling has *Solanum demissum* in parentage.)

Late maturing plants with sturdy stalks and large, tall, upright plants with strongly rugose leaves. Terminal leaflets commonly have purplish tinge. Tubers somewhat rougher than Rural; develops pinkish pigment in storage.

Resistant to late blight. Susceptible to leaf roll, rugose mosaic and scab.

Garnet Chili[11]

Originated by C. E. Goodrich in New York in 1853. Claimed to be a seedling of Rough Purple Chili.

Late maturity. Large, tall, erect plants with medium thick, medium reddish purple pigmented stems and short, narrow, green leaves. Reddish purple blossom. Tubers roundish with red skin, medium deep eyes. White flesh.

Susceptible to wart disease.

Glenmeer[47]

Developed in New York and released in 1946. N.Y. ABX/6 x 1152 (F_2 Triumph). (Female parent with *Solanum demissum* in parentage. Glenmeer and Essex are sibs or sister seedlings.)

Very late maturity. Plants very tall with very thick, heavy stalks. Heavy set of red skinned tubers. White flesh.

Drought and frost tolerant. Resistant to late blight. Susceptible to leaf roll, rugose mosaic and scab.

Gold Coin[60]

Classified as a member of the white sprout division of the Green Mountain group. Origin unknown.

Late maturity. Vines large, vigorous and well-balanced. Stems light green in color, usually distinctly winged. Leaves large, leaflets broad, smooth and more or less flaccid, medium green. Flowers abundant, white, fair size, rarely producing seed balls naturally, except under favorable climatic conditions. Tubers moderately to distinctly oblong, usually broad-flattened with more or less blunt ends. Eyes medium in number, rather shallow, with strong bud-eye clusters. Skin a dull creamy-white or light russet color when well netted. Cooking quality good.

This variety is susceptible to all of the common potato diseases.

Golden[13]

Developed and released by U.S.D.A. in 1935. USDA 43106 x USDA 43543.

Late maturity. Plants large, spreading with prominently angled slightly reddish-purple, medium thick stems. Leaves medium in length and width. White blossom. Tubers medium size, roundish, skin smooth, white. Medium shallow eyes and pale yellow flesh. Usually sets large number of tubers. Good cooking quality.

Green Mountain[11]

Originated by O. H. Alexander in Vermont in 1878. Claimed to be a seedling from a cross Dunmore and Excelsior. Ranks 13th in certified seed production, grown mostly in Maine, New Hampshire, Vermont; 6th in Canada.

Late Maturity. Large, spreading plants with thick, prominently angled, slight reddish purple to green pigmented stems and long, medium in breadth and type, green leaves. White blossom. Short-oblong to oblong, broad, flattened tubers with smooth, sometimes netted, white skin and medium deep eyes, white flesh.

Immune from wart, but susceptible to most of the common potato diseases.

Haig[63]

Developed and released in Nebraska in 1957. Neb. 223.48-1X. Cross between Cayuga and Minn. 43.

Medium to early maturity. Medium to small, erect to slightly spreading plants. Medium to small, somewhat open, glossy, dark green leaves. Oblong, blocky, slightly elliptical, medium thick uniform tubers with narrow and deep apical eyes but lateral eyes shallow. Creamy white skin developing scaly russet at maturity. Yellowish white flesh. Medium to high specific gravity. Suitable for chipping before cooling, reconstituting poorly.

High scab resistance. Apparently considerable field resistance to virus X.

Harford[47]

Developed in New York and released in 1947. Russet Rural x N.Y. AFY/5. (Seedling has *Solanum demissum* in parentage.)

Late maturity. Plants are indeterminate, tall stalks with heavy axillary growth, similar to Rural. Tubers similar to Green Mountain in size, shape and skin color.

Resistant to late blight. Drought tolerant.

Harmony Beauty[11]

Synonym: Mitchell. Originated by Alva Mitchell in Maine about 1880 from a seed ball of unknown origin.

Large, spreading plants with thick, slightly reddish purple pigmented, slightly mottled stems with long, medium in breadth and type, dark green leaves. White blossom. Tubers oblong,

flattened, with coral pink, flaked skin and medium to deep eyes and white flesh.

Susceptible to virus diseases.

Houma[14]

Developed by U.S.D.A. and released in Louisiana in 1936. Charles Downing x Katahdin.

Late maturity. Plants medium to large, erect to spreading with prominently angled, thick, green stems. Long, broad leaves. White blossom color. Tubers roundish, width greater than length, white or slightly flaked skin, medium deep to shallow eyes. White flesh. Cooks similar to Green Mountain.

Resistant to mild mosaic, net necrosis and very resistant to wart; some drought resistance. Susceptible to leaf roll and spindle tuber.

Huron[44]

Developed by Dominion Experimental Station, Fredericton, New Brunswick, from a cross Sebago x Hindenburg. Ranks 19th in certified seed production in Canada.

Very late maturity. Plants large, very vigorous, spreading at maturity. Stems uniformly bright green. Leaves long and slightly drooping. Mauve blossom. Oblong to roundish tubers with eyes medium in depth. Creamy buff skin with white flesh. High in percentage total solids and yield.

Moderately resistant to the common scab disease.

Irish Cobbler[11]

Reported to be first grown by an Irish shoemaker in Massachusetts. This circumstance is supposed to be the source of the name. Also reported named for an Irish shoemaker in New Jersey who first grew it from tubers found as a mixture in Early Rose seed. Ranks 4th in certified seed production, grown mostly in Minnesota, Maine, North Dakota; 4th in Canada.

Early to medium early maturity. Medium, erect to spreading plants with medium to thick, prominently angled, slightly reddish purple pigmented or mottled stems and light bluish green leaves medium in length, breadth and type. Lilac colored flowers. Tubers roundish with white, smooth skin and shallow to rather deep eyes. White flesh.

Immune from wart and resistant to mild mosaic. Susceptible to virus Y (rugose), leaf roll and spindle tuber.

Kasota[29]

Developed in Minnesota and released jointly by Minnesota and Nebraska in 1943. Minn. 29-13 x Triumph.

Midseason maturity. Plants medium to large, compact, dark green with thick, angled, slightly reddish stems and medium long, broad leaves. Light lavender blossom color. Tubers broadly roundish and flattened, usually wider than long, shallow eyes and smooth, reddish skin. White flesh. Cooks very much like Triumph.

Tolerant to *Fusarium solani* v. *eumartii*. Susceptible to scab and spindle tuber.

Katahdin[12]

Developed and released by U.S.D.A. in 1935. Origin: USDA 40568 x USDA 24642. Same parentage as Chippewa. Ranks 1st in certified seed production, 96 per cent grown in Maine; 2nd in Canada.

Late maturity. Plants medium to large, spreading with thick prominently angled stems having slight reddish purple cast. Leaves very long and broad. Light lilac blossom. Tubers short elliptical to roundish, medium thick with shallow eyes and smooth white skin. White flesh.

Resistant to mild mosaic. Susceptible to spindle tuber; some field resistance to leaf roll.

Kennebec[4]

Developed by U.S.D.A. and released in 1948. From a cross of two USDA seedlings B127 x 96-56. Ranks 5th in certified seed production, grown mostly in Maine, Minnesota, North Dakota; 3rd in Canada.

Medium to late maturing plants with large, spreading vines, thick prominently angled stems without pigmentation and long broad, dark green leaves. White blossom. Tubers elliptical to oblong with shallow eyes, white skin and flesh. High yield and good cooking quality, keeps well and is widely adapted.

Resistant to late blight, mosaic and net necrosis of the tuber. Susceptible to Verticillium wilt.

Keswick[1]

Developed by the Dominion Experimental Station, Fredericton, New Brunswick. Origin: *Solanum demissum* x Earlaine x Earlaine x Earlaine x Green Mountain. Ranks 17th in certified seed production, grown mostly in Maine, Wisconsin; 10th in Canada.

Medium to late maturity. Plants large, erect; stems medium to thick and slightly angled, green. Leaves moderately long, broad and midrib green. White blossom. Elliptical to oblong tubers with eyes medium in depth. Dark cream skin color with white flesh.

Susceptible to leaf roll and bunch top viruses. Resistant to the common race of late blight.

Knik[16]

Developed by Alaska, Minnesota and U.S.D.A. and released in Alaska in 1953. Arctic seedling x 56-1 (Minnesota seedling).

Late maturing plants with large, erect, predominantly single stalked, thick green stems. Leaves of medium length and width. White blossom. Tubers long, medium thick, oval with very shallow eyes. Smooth white skin and white flesh. Good cooking quality.

Resistant to common scab.

LaSalle[34]

Developed and released in Louisiana in 1948. Chippewa x inbred seedling of Triumph.

Medium early. Very upright plants, white flowers. Tubers are semi-flat, slightly oblong, with shallow eyes, white skin and flesh.

Tolerant to mild mosaic.

LaSoda[34]

Developed and released in Louisiana in 1948. Triumph x Katahdin. Ranks 27th in certified seed production, grown mostly in South Dakota, Minnesota, Nebraska.

Medium early. Plants very upright with medium to small leaves. Purple flowers. Semi-round to slightly oblong tubers with bright, pinkish red skin, very smooth. Eyes, medium in depth to shallow, white flesh. Good yielder.

Some resistance to mosaic.

Madison[47]

Developed in New York and released in 1947. Earlaine x N.Y. AMY-4. (Latter seedling has *Solanum demissum* in parentage.)

Early maturity. Emerging plants form a wide-spreading rosette growth with very large leaves and exceptionally broad leaflets having rugose appearance. Tubers large and smooth, white skin and flesh. Tendency to hollow heart in large tubers.

Resistant to late blight. Susceptible to leaf roll, rugose mosaic and scab. Drought and heat tolerant.

Manota[7]

Developed in North Dakota from Minnesota seedlings, released in Manitoba, Canada, in 1953. Cross between Minnesota seedlings 11-1-2-1 x 9-4.

Midseason maturity. Plants large, spreading at maturity; thick, upright green stems and long, green, slightly drooping leaves. White blossom. Oblong tubers with very shallow eyes. Smooth, creamy, white skin and very white flesh. Cooks and stores well.

Hollow heart occurs rarely. Susceptible to most common potato diseases.

Marygold[24]

Developed by U.S.D.A. and released in Maryland in 1949. USDA 45208 x Earlaine.

Early to midseason maturity. Plants medium spreading with thick, prominently angled, reddish purple pig-

mented stems and long, open, medium green leaves. Light blue blossom color. Roundish tubers with slightly purple shallow eyes. Smooth skin and a light yellow flesh. Good all-purpose cooking potato.

McCormick[11]

Synonyms: Late Hoosier and Lookout Mountain. Originated by Rev. T. B. McCormick in Indiana about 1882.

Large, erect plants with thick, slightly pigmented or green stems and long, narrow, open type, dark green leaves. Pink blossom. Tubers ovate to oblong, somewhat flattened with flaked, rough, flesh colored to pink skin with splashes of red. Eyes numerous, deep, red. White flesh.

Susceptible to virus diseases. Immune from wart.

McIntyre[43]

The origin of the McIntyre variety of potato is unknown. It has been grown in the province of Prince Edward Island since early times. It was first introduced to offset losses from late blight and was said to have certain resistance to that disease. Ranks 16th in certified seed production in Canada.

Very late maturing. Plants medium to large, spreading; stems thick, prominently angled. Nodes slightly swollen. Internodes reddish purple. Wings distinctly wavy and purplish. Flowers light lilac, white tips. Tubers oblong, slightly flattened. Skin yellowish mottled with pinkish-purple to purple color. Eyes numerous and deep.

Appears to have some natural resistance to late blight, virus diseases and common scab.

Menominee[65]

Developed by U.S.D.A. and released in Michigan in 1944. Richter's Jubel x USDA 44537.

Late maturity. Upright, medium to large plants with medium thick, slightly reddish purple pigmented stems and long, narrow leaves. Blossom with medium lilac colored tip. Tubers slightly wider than long, medium thick, with medium deep eyes; skin flaky to moderately russet; white flesh. Slight tendency to produce off type tubers. Long rest period, stores and cooks well.

Resistant to scab and late blight.

Merrimack[6]

Developed by U.S.D.A. and released in New Hampshire in 1955. USDA 96-56 x Saranac.

Late maturity. Large spreading plants with medium thick, prominently angled, slightly mottled stems and medium to large, closed, green leaves. White blossom. Tubers short and roundish, medium thick, shallow eyes and smooth to netted, cream to buff colored skin; white flesh. Relatively high dry-matter content, produces excellent chips and French fries, bakes well.

Resistant to late blight and ring rot, moderately resistant to early blight, field immune from virus A and highly resistant to net necrosis. Susceptible to leaf roll virus.

Mesaba[27]

Developed and released in Minnesota in 1938. Russet Rural x Minn. 41-1.

Early maturity. Plants medium large, erect and compact with prominently angled reddish stems and somewhat rugose, medium long, broad leaves. Light reddish blossom. Tubers short, medium thick, roundish with a relatively thick, smooth to slightly flaky, white skin not easily feathered and shallow eyes, white flesh.

Mohawk[21]

Developed by U.S.D.A. and released in New York in 1943. Green Mountain x Katahdin.

Late maturity. Foliage closely resembles Green Mountain. Tubers oblong-flattened, shallow eyes and white flaky skin. White flesh. Produces high yields of mealy fleshed, regularly shaped, somewhat elongated tubers.

Resistant to mild mosaic. Suscep-

tible to leaf roll and net necrosis. Moderately resistant to tipburn, flea beetle injury and hopperburn.

Nittany Cobbler[37]

Introduced by Pennsylvania Agricultural Experiment station in 1935. Claimed to be a seedling of a selfed seedling obtained from a seed ball of naturally pollinated Irish Cobbler.

(For description see Irish Cobbler for it appears to be identical to it.)

Nordak[25]

Developed in North Dakota and released in 1957. Nordak and Norgleam are sister selections from a self-pollinated seedling, ND457-1. (ND457-1 is a cross between Sebago and Minn. 92.36-5.)

Very early maturity. Medium, very erect vines with medium thick, purple pigmented stems. Medium sized, slightly closed, ovate, green leaves. White blossom. Smooth, oblong to slightly round tubers with smooth white skin, few medium to shallow eyes. Very white flesh. Excellent cooking quality.

Resistant to virus Y and silver scurf. Susceptible to scab and late blight. Sun greening is common because of short stolons.

Norgleam[25]

Developed and released in North Dakota in 1957. Norgleam and Nordak are sister selections from a North Dakota self-pollinated selection, ND457-1. (ND457-1 is a cross, Sebago x Minn. 92.36-5.)

Early maturity. Medium large, slightly spreading plants with very thick, purple pigmented stems. Medium large, slightly closed, ovate, green leaves. White blossom. Tubers oblong to slightly round, smooth, with smooth white skin and few medium to shallow eyes. Very white flesh. Excellent cooking quality.

Resistant to virus Y and silver scurf. Susceptible to scab and blight. Sun greening common because of short stolons.

Norkota[11]

Developed and released by U.S.D.A. about 1931. Rural New Yorker No. 2 x Katahdin.

Large, spreading to decumbent vines, prominently angled medium to thick green stems and long, open type green leaves. Pink blossom fades to white. Medium to large sized tubers, oblong and flattened; white flaked skin, shallow eyes, white flesh.

Somewhat resistant to hopperburn.

Norland[25]

Developed in North Dakota and released in 1957. From a cross, Redkote x ND626.

Very early maturity. Medium large, spreading vines with thick prominently angled green stems and medium large slightly closed green leaves, ovate, broad, and lobed at base. Purple blossom. Oblong smooth tubers with smooth red skin and shallow eyes, medium in number. White flesh. Produces high percentage of U.S. No. 1 tubers. Good cooking quality.

Moderately resistant to common scab. Apparently susceptible to most other common potato diseases.

Onaway[64]

Developed by U.S.D.A. and released in Michigan in 1957. Cross between Katahdin and USDA seedling B96-56.

Early maturity. Medium to large, upright plants with thick, large, prominently angled, pigmented stems. Medium to large, elliptical ovate, green leaves. Pink blossom color. Tubers elongated with smooth creamy white skin, medium deep eyes and white flesh. Tubers rough when large. Not good for chipping.

Resistant to common scab and appears to have considerable field resistance to late blight. Susceptible to tuber injury from early blight and to Fusarium wilt.

Ontario[9]

Developed by U.S.D.A. and released in New York in 1946. Richter's Jubel x USDA seedling 44537. Ranks 15th

in certified seed production, grown mostly in Wisconsin, Maine, New York.

Late maturing with medium to large, erect or often spreading vines. Medium sized, pigmented stems. Leaves long and broad. Flowers pale lilac color. Tubers oblong, white skin that sets rather early, shallow eyes. White flesh. Heavy yields. Definite tendency to cook dark.

Very resistant to scab, late blight resistant and *Fusarium solani* var. *eumartii* tolerance. Susceptible to internal necrosis. Under unfavorable conditions may form sprouts and secondary tubers at the bud end.

Osage[18]

Developed in Colorado (U.S.D.A.) and released in Iowa and Colorado in 1954. USDA X245-186 x Katahdin.

Medium maturity. Plants medium in size, spreading, with prominently angled stems, having green with occasional purplish mottle. Flowers pale lilac. Tubers predominantly long cylindrical, somewhat flattened, uniform, with smooth, light tan skin and shallow eyes. White flesh. Slow to break dormancy. Good cooking quality. Tendency to set few tubers.

Resistant to scab. Susceptible to late blight. Tendency to develop hollow heart.

Osseo[31]

Developed and released in Minnesota in 1954. Cobbler x Minnesota 56-1.

Early maturity. Plants distinctly upright and compact with thick, sturdy stems, wiry wings and slight pigmentation. Leaves large with broadly ovate leaflets. White blossom. White tubers, round, blocky, smooth, uniform in size, few, if any, small size. White flesh. Useful wherever an extra early white variety is desired.

Pawnee[17]

Developed by U.S.D.A. and released in Colorado in 1943. Rural New Yorker No. 2 x Katahdin. Ranks 18th in certified seed production in Canada.

Medium early maturity. Plants medium sized, spreading, with medium thick, angled, purple tinged stems and long, medium broad leaves. Violet colored blossoms. Tubers short, roundish, medium thick with smooth, white skin and few, shallow eyes. White flesh. Good cooking quality.

Peerless[11]

Pearl and Bresee's No. 6 are synonyms for this seedling originated by Albert Bresee in Vermont in 1862. Seedling of Garnet Chili from the same seed ball as Early Rose.

Large spreading plants with white blossoms. Large to medium, round, flattened tubers with white skin and pinkish tinge around eyes that fades during storage.

Susceptible to several virus diseases, tendency to produce knobby tubers under unfavorable conditions.

Pennigan[38]

Claimed to be a cross between Russet Rural and McCormick. Introduced in 1938 by Pennsylvania Experiment Station.

(For description see Rural New Yorker No. 2 for it appears to be identical to it.)

Perfect Peachblow[11]

Origin unknown.

Large, spreading plants, with thick, slightly mottled reddish purple pigmented stems and leaves medium in length, breadth and type. Light reddish purple blossom. Tubers round, flattened with reddish pink skin and few, shallow eyes, bud-eye cluster frequently depressed. White flesh.

Immune from wart.

Placid[46]

Developed in New York, released in 1946. ABX/6 x AFY/5. (Both New York seedlings have *S. demissum* in parentage.)

Mid to late season maturity. Erect growth at emergence becoming nearly prostrate, profuse axillary shoot growth, sturdy, thick green stems. Leaves short, compact, moderately

rugose, dark green. Lavender flower color. Tubers: skin warm buff with shallow eyes. White flesh, not as smooth as Katahdin.

Resistant to late blight. Susceptible to common scab and leaf roll.

Plymouth[58]

Developed by U.S.D.A. and released in North Carolina in 1955. Mohawk x USDA 96-56. Ranks 30th in certified seed production, grown mostly in Wisconsin, New York, Maine.

Medium maturity. Large spreading plants with prominently angled, medium thick green stems. Leaves medium long, closed, medium green. White blossom. Oblong-flattened, medium thick tubers with flaky, white skin and shallow eyes. White flesh. High yielder, total solids similar to Cobbler, above Sebago. Good variety for making potato chips.

Resistant to late blight. Moderately resistant to common scab.

Pontiac[36]

Developed by U.S.D.A. and released in Michigan in 1938. Triumph x Katahdin. Ranks 9th in certified seed production in Canada, 31st in United States.

Late maturity. Plants with upright vigorous and spreading growth, thick, slightly pigmented stems with dark green, long, broad to medium, rough-textured leaves. Blossoms have reddish purple color. Tubers round to oblong with smooth to flaky light red colored skin, medium deep eyes and white flesh.

Susceptible to most common potato diseases.

Potomac[23]

Developed by U.S.D.A. and released in Maryland in 1945. Rural New Yorker x Katahdin.

Late maturity. Large spreading plants with prominently angled, reddish purple stems. Long, broad, open, dark green leaves. Light lilac blossom color. Tubers are short elliptical to roundish with smooth, white skin and medium shallow eyes. White flesh. Good all-purpose cooking quality.

Resistant to late blight and to the flea beetle, leaf hopper and tipburn complex.

Progress[63]

Developed and released in Nebraska in 1950. U.S.D.A. 0183 x Minn. 5-10-3-8. Ranks 21st in certified seed production, grown mostly in Nebraska.

Early maturity. Medium to small plants with thin flexile stems. Medium to small, dark green leaves. Medium to pale heliotrope blossom color. Ovate to slightly oblong, medium to small tubers with intermediate to dark red, smooth skin. Under irregular environmental conditions tubers likely to have many small, angular growth cracks. White flesh. Rather heavy tuber set. Intermediate specific gravity —higher than Red Pontiac. Seldom suitable for chips, satisfactory for baking.

Intermediate to high scab resistance.

Pungo[39]

Developed by U.S.D.A. and released in Virginia in 1950. Cross between USDA seedlings 96-44 x 528-170. Ranks 24th in certified seed production, grown mostly in Maine.

Early to medium early maturity. Large spreading plants with medium thick, prominently angled ,green stems. Medium long, broad, open type, medium green leaves. White blossom. Elliptical, somewhat rounded tubers with white, flaked skin, medium deep eyes and white flesh. Yields well, large tubers may become rough.

Resistant to late blight.

Quick Lunch[11]

Claimed to be a seedling of Peachblow originated by Gideon Safford in Vermont in 1890 but according to Clark and Lombard[10] it appears to be identical with Noroten Beauty and Pride of the South, both sports or mutants of Triumph.

Redbake[63]

Developed and released in Nebraska in 1956 from a cross derived from Minnesota lines 5-10-, 41-2-10-1 and Colorado 3719.

Medium maturity. Medium size, compact plants with erect to spreading stems. Medium to small relatively open and medium to dark green leaves. Deep heliotrope blossom color. Oblong, slightly ovate, flat tubers with shallow eyes and intermediate red, smooth or slightly netted skin. Yellowish white flesh. Intermediate yield, high percentage U.S. No. 1. Very high specific gravity. Very good for chipping, reconstituting very well after cold storage.

Red Beauty[49]

Developed in North Dakota and released in Wisconsin in 1955. North Dakota seedling N.D.1 x Cayuga.

Midseason maturity. Plants have upright growth, medium size. Tubers have bright red skin color, with few shallow eyes. Very white flesh. Average yielding ability. Good cooking quality.

Resistant to Verticillium wilt, tolerant to purple top virus (aster yellows). Susceptible to rugose mosaic and common scab.

Redburt[20]

Selected from a field of the Satapa variety in Minnesota in 1949. Released in 1953.

Medium late maturity. Plants medium size, spreading, with prominently angled, reddish purple, thick stems. Medium sized, closed, green leaves. Light purple blossom color. Tubers large, oblong, medium thick with smooth, red skin, medium deep eyes, white flesh. High specific gravity. Seed stocks of this variety now being grown in Minnesota and Wisconsin are very nearly identical in morphological characters to LaSoda variety.

Redglo[63]

Developed and released in Nebraska in 1954. Minnesota 29.32-1-34, 5-10-3-23-2, 11-1-3-2, and Pontiac.

Late maturity. Medium to large vines with thick, erect stems. Medium sized, open, light green leaves. Medium heliotrope blossom color. Tubers oblong, ovate, slightly flat with deep apical eyes and intermediate lateral eyes. Very dark glossy red skin, white flesh. Specific gravity slightly higher than Red Pontiac. Poor chipping quality.

No known disease resistance.

Redkote[42]

Developed and released by Mr. Ben Picha, Grand Forks, North Dakota in 1953. USDA 116-10 x Pontiac.

Late maturity. Plants large, upright, vigorous, with large, heavily pigmented stems. Deep lavender blossom color. Tubers are oval shaped, uniformly sized, blocky, with shallow eyes and rosy red skin color, slight netting. White flesh. High dry matter content. High yielder.

Resistant to common scab and internal discoloration.

Red LaSoda[61]

Clonal mutation selected from the LaSoda variety. Released in 1954. Except for tuber color it is identical to the LaSoda. Ranks 8th in certified seed production, grown mostly in Nebraska, Wisconsin, South Dakota.

Red McClure[11]

This variety is apparently a sport of Perfect Peachblow, differing only in color of tubers, the Red McClure having a somewhat netted, red skin while the Peachblow has a pinkish skin. Ranks 11th in certified seed production, grown mostly in Colorado, Wyoming.

Susceptible to virus diseases. Immune from wart.

Red Pontiac

Clonal mutation selected from Pontiac variety. Except for a much more intense red skin color it appears to be identical to the Pontiac variety. As far as is known this mutation was first picked up in Florida by Mr. J. W. Weston about 1949 and increased in North Dakota. It was known as Da-

kota Chief by the trade for some time but certified as Red Pontiac. Ranks 3rd in certified seed production, grown mostly in North Dakota and Minnesota; 7th in Canada.

Red Warba[28]

Clonal mutation (Chimera) of the Warba variety developed in Minnesota about 1939. Ranks 25th in certified seed production, grown mostly in Minnesota, North Dakota, Wisconsin.

Early maturity. Except for tuber color it is the same as the Warba. The seed stocks being grown as Red Warba all show a tendency to have uncolored or blotchy areas on the skin of the tubers. About four years ago (1953) a mutation was selected at Starks Farms in Wisconsin that retains a uniform red color although it is very slightly lighter under some conditions.

Susceptible to most common potato diseases.

Rukat[2]

Developed by W. P. Raleigh of Kansas and introduced in 1954 from a cross, Russet Rural x Katahdin.

Midseason or later. Plants medium size with some purple pigmentation in stems. Purplish violet blossom. Oval flattened tubers with white or slightly russet skin. Tubers maintain shape well even under adverse growing conditions. Chips well and should be considered as a possible replacement for Russet Rural. High specific gravity.

Rural New Yorker No. 2[11]

There are perhaps more synonyms for this variety than any other grown. Some of the most commonly known are Carman No. 3, Mortgage Lifter, Noxall, White Globe, World Wonder, Heavyweight, Pioneer Rural, No. 9, Toanco No. 4, Robson's Seedling and Mason Rural. It is also designated in commercial circles as Smooth Rurals and White Rurals. This variety was originated by E. S. Carman, editor of the Rural New Yorker, and claimed to be a seedling from parentage of indefinite origin. Introduced in 1888. Ranks 29th in certified seed production in United States, grown mostly in Michigan, Maine, New York.

Large, erect plants with thick, prominently angled, mottled, medium purple pigmented stems. Leaves medium in length, breadth and type, dark green. Purplish violet blossom. Tubers broadly oblong, flattened with smooth, occasionally netted, white skin and few, shallow eyes. White flesh. Carries a genetic factor for russet tubers.

Susceptible to most common potato diseases.

Rushmore[35]

Developed in Louisiana. Released in 1957. Katahdin x Green Mountain.

Medium early maturity. Plants are medium upright in growth with white blossoms. Tubers are oblong and russeted but brighter and lighter than Russet Burbank. Cooking and baking quality is excellent. Medium yield.

Susceptible to common scab.

Russet Burbank[11]

Synonyms: California Russet, Idaho Russet, Golden Russet, Netted Gem. Origin of Russet Burbank is unknown. Ranks 2nd in certified seed production, grown mostly in Idaho, Maine, Montana and Oregon; 5th in Canada.

Late maturity. Plants large to medium in size, spreading with thick, prominently angled, slightly reddish purple pigmented, finely mottled stems and long leaves, medium in breadth and type, light green color. White blossom. Tubers large, long, cylindrical or slightly flattened with russeted, heavily netted skin and numerous, well distributed, shallow eyes and white flesh. Good cooking quality, particularly baking.

Somewhat resistant to common scab but susceptible to other common potato diseases.

Russet Rural[11]

Synonyms: Late Petosky, Dibbles Russet and Rural Russet. This variety is regarded as a sport or mutation of Rural New Yorker No. 2 (Katila)

found in Michigan in 1903. Ranks 14th in certified seed production, grown mostly in Maine, Michigan, New York; 8th in Canada.

See Rural New Yorker No. 2 for plant characters, otherwise the Russet Rural has the russet skin character.

Somewhat resistant to common scab.

Russet Sebago[62]

Russet Sebago is a clonal selection from Sebago. Released about 1947. Ranks 20th in certified seed production, grown mostly in Wisconsin, Maine.

Its thick russet type skin makes it less subject to mechanical injury and it is somewhat more resistant to common scab than Sebago. Otherwise it is identical to Sebago in its morphological characters or appearance.

Saco[5]

Developed by U.S.D.A. and released in Maine in 1955. USDA 41956 x USDA 96-56. Ranks 22nd in certified seed production, grown mostly in Maine.

Late maturity. Plants large to medium, spreading, with prominently angled, medium thick green stems. Large to medium leaves, closed, green. White blossom. Tubers short and round, medium thickness and flattening toward stem end, smooth white skin and shallow to medium shallow eyes. White flesh. Tendency to produce off type tubers. High dry matter content. Good for making chips.

Resistant to late blight and net necrosis, immune from mild mosaic (A+X) and latent mosaic (X).

Saranac[54]

Developed by U.S.D.A. and named in Australia in 1949. President x Katahdin.

Late maturity. Plants large, erect, with medium thick, slightly angled green stems and with medium width and length leaves. White blossom. Tubers round, flaked, white skin, shallow eyes and white flesh.

Resistant to ring rot and late blight. Susceptible to leaf roll.

Satapa[30]

Developed and released in Minnesota in 1949. Red Warba x Minn. seedling 20-4.

Midseason maturity. Plants medium in size, spreading, with thick, slightly pigmented stems. Leaves long, medium wide, rugose and dark green. Blossom color deep red, purple. Tubers round, slightly flattened, thick, short, with very shallow eyes. Skin is pale red and flesh is white. Produces few small tubers, very good cooking quality.

Sebago[53]

Developed by U.S.D.A. and released in Maine in 1938. Chippewa x Katahdin. Ranks 10th in certified seed production, grown mostly in New York, Wisconsin, Michigan; 1st in Canada.

Maturity late. Plants are large, erect to spreading with thick, prominently angled, slightly reddish purple pigmented stems. Medium long leaves, broad, open. Reddish purple blossom. Tubers elliptical to round with smooth, white skin and shallow eyes. White flesh. Tendency to set few tubers. Good cooking quality, makes good chips.

Resistant to late blight, mild mosaic, common scab and yellow dwarf. Susceptible to leaf roll and spindle tuber.

Sebec[11]

Origin unknown.

Plants are large and spreading. Tubers are small, oblong to elliptical, have deep eyes and the flesh is faintly yellow.

Variety is of no commercial importance but carries a genetic factor for purple tuber color of interest to potato breeders.

Seneca[9]

Developed by U.S.D.A. and released in New York in 1946. Origin: Hindenburg x Katahdin.

Late maturing. Plants medium large, spreading growth with medium thick green stems. Medium sized leaves. Flowers pale violet. Tubers round to slightly elongated, medium deep eyes,

slightly russeted creamy colored skin. Flesh very slightly yellow.

Resistant to scab, late blight and *Fusarium solani* var. *eumartii*.

Sequoia[19]

Developed by U.S.D.A. and released in North Carolina in 1939. Green Mountain x Katahdin. Ranks 17th in certified seed production in Canada; 28th in the United States, grown mostly in North Carolina, Michigan, Maine.

Late maturity. Plants large, erect with prominently angled thick green stems and long, broad, medium type leaves. White blossom. Tubers roundish to somewhat oblong, thick, with smooth to somewhat russeted cream colored skin, shallow eyes and white flesh. Under certain conditions produces rough, oversize tubers with a tendency to hollow heart.

Resistant to flea beetles and leaf hoppers. Resistant to late blight but tubers are susceptible.

Sheridan[63]

Developed and released in Nebraska in 1953. Triumph x Nebraska seedling 49.30-3. (Sib of Dazoc.)

Early maturity. Small, erect, compact vines with medium to thin, firm stems. Leaves small, open, very dark green. Light heliotrope blossom color. Very good tuber type, oblong to round or ovate to spherical with shallow eyes. Smooth, bright, medium red skin. White flesh. Medium specific gravity—somewhat better than Red Pontiac. Fair chipping quality.

No known disease resistance. Apparently highly susceptible to late blight tuber rot.

Snowdrift[47]

Developed in New York and released in 1947. New York seedling having *Solanum demissum* in parentage x Earlaine.

Early maturing. Characteristics and adaptation compare with Chenango. Unusually white skin and flesh.

Resistant to late blight.

Spaulding Rose[11]

Synonyms: King, Pride of the West, Rose No. 4, Spaulding No. 4. Origin is unknown.

Late maturity. Plants large, spreading with thick, mottled, reddish purple pigmented stems and long, narrow, open type, green leaves. White blossom. Tubers broadly oblong, flattened, with smooth, red skin, medium deep eyes and white flesh sometimes streaked with pink.

Immune from wart and resistant to mild mosaic.

Tawa[41]

Developed by U.S.D.A. and released in Iowa in 1956. USDA B595-76 x USDA B76-23.

Early maturity. Medium to large, spreading plants with medium thick, green stems and long, broad, medium open leaves. White blossom. Tubers are predominantly short, elliptical and thick with smooth white skin, shallow eyes and white flesh. Good cooking and chipping qualities.

Immunity to latent mosaic (virus X), resistance to mild mosaic (virus A), late blight and common scab.

Teton[48]

Developed by U.S.D.A. and released in Wyoming in 1946. Origin: USDA seedling 45146 x Earlaine. Ranks 18th in certified seed production, grown mostly in Maine.

Late maturing variety with large, spreading vines with thick green stems. Leaves long, broad, open, dark green. White blossom. Tubers round to oblong, slightly flattened, few shallow eyes. Smooth light yellow skin. White flesh. Good cooking quality.

Resistant to ring rot.

Triumph[11]

Synonyms: Bliss, Bliss Triumph, Red Bliss, Coconimo Red, Hawaiian Rose, Stray Beauty. Originated in Connecticut in 1878 by B. K. Bliss and Sons and claimed to be a seedling of a cross between Peerless and Early Rose. Ranks 12th in certified seed produc-

tion, grown mostly in Minnesota, North Dakota, Nebraska; 13th in Canada.

Plants large to medium, spreading with thick, slightly angled, medium reddish purple pigmented stems and long, broad, medium type leaves. Pink blossom. Tubers round, thick, with smooth red skin, medium deep eyes and white flesh.

Susceptible to most or possibly all of the common potato diseases, including wart.

Up-To-Date[11]

The use of "British Queen" as a synonym for Up-To-Date is applicable only in the United States, particularly in some Western states where stocks of Up-To-Date are erroneously called "British Queen". The true British Queen variety originated in Great Britain and probably is not grown in the United States. Originated by Archibald Findlay in the late eighties from a cross between Patterson's Victoria and Blue Don.

Late maturity. Plants large and spreading with thick, mottled, medium reddish purple pigmented stems and very long, broad, closed type, green leaves. Light reddish purple blossom. Oblong, flattened tubers with a somewhat flaked, cream colored skin and few, very shallow eyes and white flesh.

Susceptible to virus diseases and wart.

Virgil[46]

Developed in New York, released in 1946. Origin: 1145 x ZH2. (New York seedlings with *Solanum demissum* in parentage.)

Medium to late maturing. Vines have several sturdy green stalks with semi-erect growth habit and strongly rugose type leaves, pale green. Lavender colored flowers. White skin and flesh, few deep eyes.

Late blight resistant. Susceptible to rugose (virus Y) and common scab.

Warba[26]

Developed and released in Minnesota in 1933. Triumph x Minn. 4-16. Ranks 15th in certified seed production in Canada.

Early maturity. Plants medium in size, spreading with thick, prominently angled, green stems and long, medium wide dark green leaves. Pink blossom. Tubers are medium in size, short, round, with creamy white skin and rather deep, red eyes. White flesh.

Susceptible to mosaic and wart.

Waseca[30]

Developed and released in Minnesota in 1949. Triumph x Minn. seedling 15-2-10. Ranks 26th in certified seed production, grown mostly in Minnesota.

Very early maturity. Plants small to medium size, compact to spreading with medium thick, slightly pigmented stems. Long, narrow, slightly rugose, dark green leaves. White blossom, tinged with purple. Medium to large oblong to round tubers with medium shallow eyes. Reddish skin color and white flesh. Produces medium to large tubers, very few small size.

White Cloud[63]

Developed by breeders at North Dakota and Nebraska and released in Nebraska in 1950. Derived from a cross Warba x Katahdin.

Early maturity. Medium to small spreading plants with large, closed, medium to light green leaves. Blossom is large with faint heliotrope color. Tubers oblong thick, intermediate size, uniform, with medium to shallow eyes. White skin, slightly flaky; white flesh. High specific gravity, good baking quality, good to fair chipping quality.

Highly susceptible to common scab. Hollow heart prevalent under some conditions.

White Gold[11]

Originated by Mr. George Kramer in Minnesota and claimed to be a seedling of Green Mountain.

Medium sized, spreading plants with medium sized, green stems and leaves medium in length, breadth and type.

White blossom. Tubers oblong to roundish with smooth, white skin, medium deep eyes and white flesh.

White Pontiac

A sport of Pontiac which it resembles in every respect except that the tubers are white.

White Rose[11]

Synonyms: American Giant, Wisconsin Pride, Late Pride, California Long Whites, Long Whites. A variety known as American Giant is claimed to have been originated by Mrs. Rachel Chapman of New York State in 1893 from a seed ball of the Jackson potato. Since the American Giant is no longer grown commercially the preferred name White Rose is used to designate this variety. Ranks 6th in certified seed production, grown mostly in California, Washington, Oregon.

Late maturity. Large, spreading plants with prominently angled, green or slightly reddish purple pigment on upper part of medium thick stems and with leaves medium in length, breadth and type. White blossom. Large, long, elliptical flattened tubers with smooth, white skin and numerous, medium deep eyes. White flesh.

Susceptible to most common potato diseases, including wart.

White Triumph

A sport of Triumph which it resembles in every respect except that it has a white skin and eyes.

Yampa[52]

Developed by U.S.D.A. Released from Colorado in 1949. Origin: USDA seedling 245-186 x Katahdin.

Medium early, erect, medium sized plants with thick prominently angled green stems. Broad, open type, medium long, bluish-green leaves. White blossom. Round to blocky tubers with shallow eyes and a white to light russet skin. White flesh. Very good cooking quality.

Resistant to scab, early blight, leaf roll and mosaic.

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Breeding New Varieties of Potatoes

THE SELECTION of suitable parental stocks is the initial step in breeding new varieties. The next step is to bring each of the parental selections into flower at approximately the same time. Cool temperatures and high light intensities are essential for good flowering and fruit set of the potato. The hybridization or "crossing" programs of most American potato breeding projects are, therefore, conducted in the greenhouse during the cool, bright days of the Spring season.

The breeder has a choice as to whether he uses a particular breeding selection as a female or as a male in making the cross since each potato flower contains both male and female parts. If the selection is to be used as a female the five male parts, called the anthers, are removed with a forceps before the flower opens (Fig. 1). The remaining central portion of the flower is known as the pistil and is the female portion of the flower (Fig. 2).

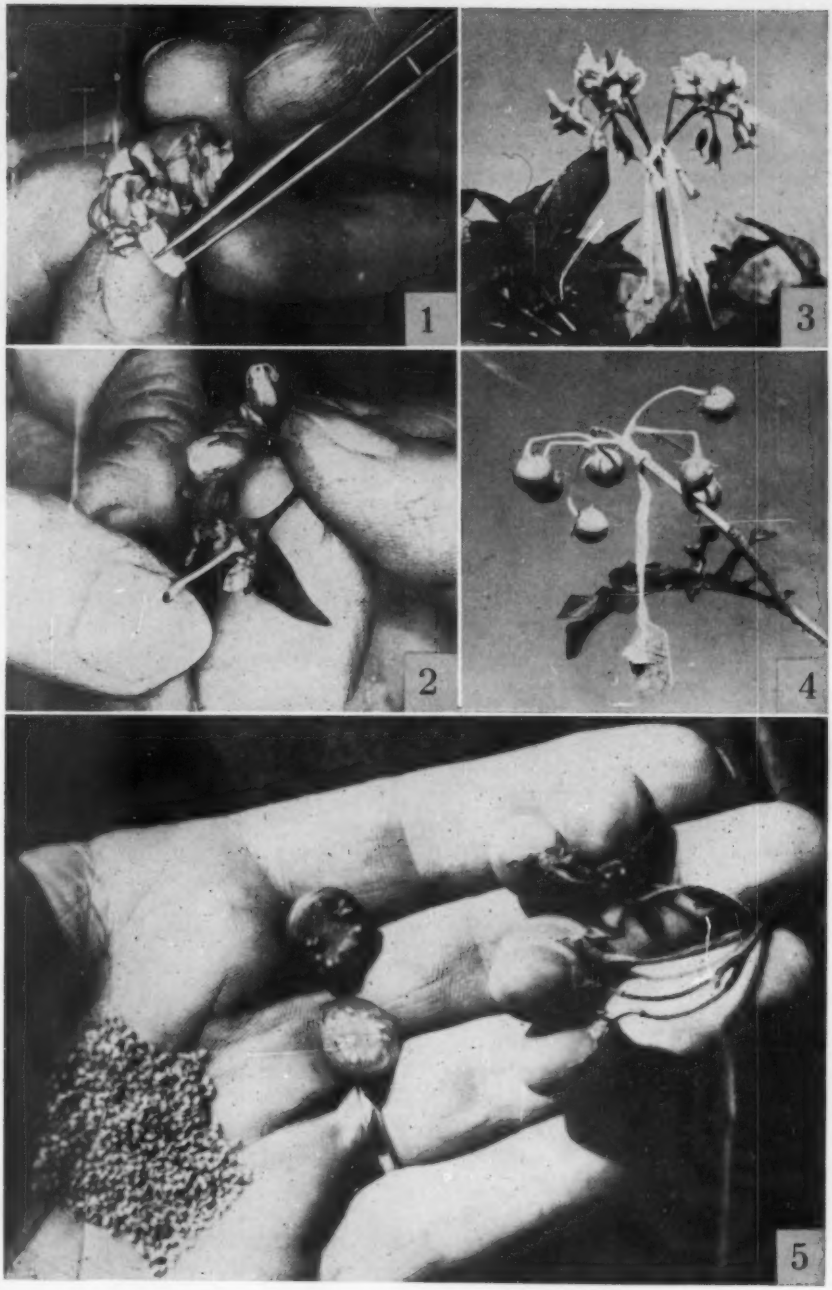
Pollen from the selection to be used as the male parent may be collected either in a small capsule using a mechanical vibrator or by gently tapping the anthers on the thumbnail. The pollen is rubbed on the "stigma" (the apical portion of the pistil) of the selection which is to be used as the female parent (Fig. 2). The male and female parent are identified, following pollination, on a small tag which is attached to the base of the inflorescence of the female parent (Fig. 3). Within a few days after the pollination has been made the ovary, which is the basal portion of the pistil, begins to enlarge forming the fruit. At the end of 4-5 weeks the fruit, (seedball), is ¾—1 inch in diameter and will soon be ready for harvest (Fig. 4).

A simple method of extracting the seed is to cut the seedball in half (Fig. 5) and squeeze the 150 or more seeds of each fruit into a glass of water. After the seeds have been extracted, dried (Fig. 5) and packaged they are generally allowed to stand for several months until the dormancy is broken.

The seed is planted during the summer or early fall in either vermicullite or sterilized soil. Each of the several state, federal and private breeders of this nation grow an estimated 15,000 to 50,000 new potato seedlings annually. Methods for "screening" of young seedling populations, often in the pretransplant stage, have been developed for some diseases of the potato (e.g. late blight and X virus). Methods such as these, which allow for the elimination of undesirable seedlings (i.e. those disease-susceptible) at an early stage, have markedly increased the efficiency of modern potato breeding.

The young seedlings are transplanted to individual pots when they are about one inch in height. The potted seedlings will produce a crop of small tubers (Fig. 6) in 3½—4 months after transplanting. Each plant of the first-year seedling population has, for all practical purposes, a different genetic constitution (i.e. genotype). Since subsequent propagation of seedling plants will be asexual (i.e. through tuber seed-pieces) the genotype of each seedling plant can, with limited exceptions, be easily maintained in a very stable form. This is fortunate indeed for once an elite selection (i.e. a potential new variety) has been made no further effort is required, by either the breeder or the commercial grower of seed potato or table stock, insofar as maintenance of the selected genotype. This is in marked contrast to sexually-propagated crops, such as hybrid corn, which require considerable effort and expense in maintaining the desired genotype of the commercial variety.

Once the dormancy of the small, first-year, greenhouse-grown tubers is broken they may be planted in the field. From this point onward the potato breeder utilizes, with suitable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modifications, many of the standard practices and much of the standard machinery of the commercial trade. The small, first-year tubers are planted without cutting and the plantings may be made with an assisted-feed planter. By use of rather large spacing between seed pieces (e.g. 2½—3 feet) the second-year crop, as well as subsequent properly-spaced, seedling crops may be dug with a single-row, level-bed digger.

The task confronting the breeder, as he grows the thousands of new, young seedlings, is to recognize and select the elite individuals which possess the combination of characters es-

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sential to superior commercial varieties. The great majority of seedlings will carry characters which make them unsuited for commercial purposes. Ninety-five percent or more of all the seedling potatoes will be discarded as a result of screening for various characters (e.g. disease-resistance, vigor and tuber characteristics) in the first and second year of propagation. Tubers from the most promising individual hills (i.e. clones) of the second-year seedling crop will be selected and harvested for further testing. The tuber increase of each seedling clone is now sufficient for multiple-hill plantings in the third year. Plantings are often made in the third year at two or more locations. Such plantings enable the breeder to more efficiently evaluate his promising selections for general adaptibility (e.g. adaptibility to different soil types and climatic conditions). The breeder strives, by such measures, to reveal the faults and weaknesses of the seedling selections by subjecting them to trials of increasing intensity. This pattern of evaluation eventually includes testing of the few remaining selections for yielding ability.

Yielding ability is judged by comparing the promising selections with standard commercial varieties. The breeder employs accepted field plot designs, usually 25-hill, randomized rows in 4-replicate plots, and in making these comparisons treats his data with standardized methods of statistical analysis. Selections which appear outstanding in these preliminary trials are increased for further, larger-scale tests. These superior selections are usually subjected to such commercial-type tests for four or more years before they are considered properly evaluated. It is more or less agreed among potato breeders that to be eligible for varietal rank a seedling selection must (1) possess the desirable characteristics of the standard commercial varieties (i.e. culinary quality, horticultural type, adaptability, etc.) and (2) be superior in at least one major characteristic (e.g. resistance to an economically-important disease). Once a selection is judged worthy of varietal status it is named and properly described in the literature (e.g. in the American Potato Journal). Limited quantities of seed are then officially released to commercial seed-potato growers.

The changing needs of industry place ever-increasing demands upon the breeder. To meet these needs the breeder must often search for parental stocks with new or better characters (e.g. multiple or higher resistance to diseases and pests). Occasionally the desired character cannot be found among the domestic breeding stocks and the search must be expanded to include stocks from abroad. American and European potato breeding stations have enjoyed an exchange of breeding material for many years. The pedigrees of modern varieties bear witness to the effectiveness of this exchange.

A huge reservoir of new germ plasm for potato breeding is found among the numerous native potato species of South America, Central America and Mexico. To date the outstsanding example of the use of such material is the development of late-blight resistant commercial varieties (e.g. Kennebec Fig. 7, left) through matings of the common potato, *Solanum tuberosum*, and the wild, late-blight resistant Mexican species, *Solanum demissum*, (Fig. 7, right). Modern potato breeders, recognizing the potential of the species from Latin America and Mexico for potato improvement, have arranged for the systematic introduction as well as for making the introduced materials readily available through special preservation centers. The exact path of future potato improvements is impossible to predict but it seems safe to assume that breeders will continue to exploit this wealth of genetic material in the development of new and better potato varieties for the commercial trade of tomorrow.

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Production of Certified Seed Potatoes by Varieties — 1958

Compiled by ORRIN C. TURNQUIST

	Acres Entered	*Acres Passed*
ANTIGO		
Wisconsin	125.00	82.00
BLISS TRIUMPH		
South Dakota	446.00	409.00
Minnesota	486.00	390.00
North Dakota	358.00	358.00
Nebraska	193.80	191.80
Montana	91.00	91.00
Canada	63.00	55.00
Maine	53.00	52.00
Oregon	—	22.00
Total	1,690.80	1,568.80
BOONE		
Nebraska	2.80	2.80
Tennessee	1.50	1.50
Total	4.30	4.30
BURBANK		
Michigan	60.00	60.00
Wyoming	74.00	57.00
Oregon	—	38.00
Total	134.00	155.00
CANSO		
Canada	181.00	158.00
Nebraska	16.00	16.00
Total	197.00	174.00
CASCADE		
Oregon	—	1.00
CAYUGA		
Nebraska	5.80	5.80
CHEROKEE		
Minnesota	955.00	819.00
Maine	346.00	305.00
Michigan	199.00	130.00
Canada	96.00	81.00
New York	15.00	15.00
Vermont	13.00	13.00
Wisconsin	6.00	6.00
South Dakota	4.00	4.00
Colorado	26.00	0.00
Utah	2.00	0.00
Total	1,662.00	1,373.00
CHIPPEWA		
Wisconsin	570.00	480.00
Maine	325.20	298.30
New York	248.00	248.00
Canada	205.00	182.00
Minnesota	42.50	40.50
North Dakota	5.00	5.00
Vermont	4.00	4.00
Michigan	70.00	0.00
New Jersey	32.50	0.00
Total	1,502.20	1,257.80
COLUMBIA RUSSET		
Canada	120.00	105.00
DAKOTA WHITE QUEEN		
North Dakota	4.00	4.00
DAZOC		
Nebraska	461.61	451.61
Minnesota	276.60	205.60
North Dakota	89.00	66.00
Wisconsin	73.00	50.00
Colorado	46.49	46.49
California	13.00	13.00
Idaho	18.00	8.00
Michigan	7.50	7.50
Oregon	—	3.00
Total	985.20	851.20
DELUS		
New York	9.00	9.00
Maine	5.00	3.00
Colorado	0.50	0.50
Pennsylvania	1.00	—
Total	15.50	12.50
EARLY GEM		
North Dakota	1,320.75	1,015.25
Wisconsin	606.00	520.00
Idaho	159.50	158.00
Minnesota	167.60	136.60
Nebraska	—	96.70
Montana	30.00	30.00
Oregon	—	9.00
Colorado	4.00	4.00
Total	2,287.85	1,969.55
EARLY OHIO		
North Dakota	254.50	254.50
Minnesota	298.00	243.00
Canada	52.00	52.00
Wisconsin	37.00	37.00
South Dakota	29.00	29.00
Total	670.50	615.50

	Acres Entered	*Acres Passed*
EARLY ROSE		
Canada	11.00	9.00
Maine	10.00	0.00
Total	21.00	9.00
EXCEL		
Nebraska	33.20	33.20
GOLDEN CHIP		
Oregon	—	31.10
GREEN MOUNTAIN		
Canada	4,081.00	2,365.00
Maine	548.00	517.00
Vermont	63.00	41.00
New Hampshire	31.00	31.00
New York	15.00	15.00
Minnesota	11.00	9.30
Michigan	4.00	4.00
Wisconsin	4.00	1.00
Total	4,757.00	2,983.30
HAIG		
Nebraska	62.76	44.76
HOUMA		
New Hampshire	0.30	0.30
HURON		
Canada	313.00	263.00
Wisconsin	6.00	6.00
New York	1.00	1.00
Minnesota	2.75	0.10
Total	322.75	270.10
IRISH COBBLER		
Minnesota	11,502.00	9,898.00
Canada	3,108.00	2,775.00
Maine	2,599.00	2,510.00
North Dakota	1,564.00	1,265.00
South Dakota	133.00	133.00
Colorado	66.30	66.30
Wisconsin	49.00	49.00
Wyoming	29.00	29.00
Pennsylvania	26.00	26.00
New York	24.00	24.00
Iowa	20.00	20.00
Nebraska	10.00	10.00
Vermont	4.00	4.00
New Jersey	2.50	—
Total	19,136.80	16,809.30
KATAHDIN		
Maine	67,904.00	55,724.00
Canada	9,260.00	7,424.00
New York	1,133.00	1,125.00
Vermont	416.50	408.50
Pennsylvania	407.50	407.50
Wisconsin	360.00	273.00
Colorado	196.28	130.26
Michigan	143.00	123.00
Delaware	67.00	67.00
New Hampshire	8.00	8.00
Minnesota	4.00	4.00
Idaho	4.00	4.00
Oregon	—	2.00
New Jersey	42.50	—
Total	79,945.78	65,700.26
KENNEBEC		
Canada	7,167.00	5,791.00
Maine	6,194.00	5,595.00
Minnesota	1,670.00	1,633.00
North Dakota	1,302.25	1,068.60
Oregon	—	465.00
California	502.00	382.00
Wisconsin	355.00	256.00
Idaho	188.50	186.00
New York	141.00	137.00
South Dakota	116.00	116.00
Nebraska	34.50	34.50
Wyoming	28.00	28.00
Pennsylvania	25.00	25.00
Colorado	24.00	23.00
Montana	10.00	10.00
Michigan	5.00	5.00
New Jersey	3.50	—
Utah	45.00	0.00
Total	17,810.75	15,755.10
KESWICK		
Canada	850.00	660.00
Maine	414.00	292.00
Wisconsin	148.00	110.00
Total	1,412.00	1,062.00
LASODA		
South Dakota	5.00	5.00
Minnesota	3.00	3.00
Michigan	1.00	1.00
Total	9.00	9.00
MANOTA		
Canada	51.00	51.00
MERRIMACK		
Maine	28.00	28.00
New York	9.00	9.00
Michigan	2.00	2.00
Wisconsin	1.00	1.00
New Hampshire	0.50	0.50
Total	40.50	40.50
NEW WHITE		
Minnesota	53.00	53.00
Utah	7.00	0.00
Total	60.00	53.00

	Acres Entered	Acres Passed
NORGLEAM		
North Dakota	0.10	0.10
NORLAND		
North Dakota	421.50	336.45
Minnesota	264.80	152.30
Wyoming	6.00	6.00
Colorado	3.66	3.66
Wisconsin	3.00	3.00
Total	698.96	501.41
ONAWAY		
Michigan	73.00	70.00
ONTARIO		
Maine	632.00	148.00
New York	121.00	121.00
Wisconsin	320.00	95.00
Michigan	5.00	5.00
North Dakota	2.00	2.00
Total	1,080.00	371.00
OSAGE		
Minnesota	7.00	7.00
OSSEO		
Minnesota	2.50	2.50
PAWNEE		
Canada	1.00	1.00
Wisconsin	1.00	1.00
Total	2.00	2.00
PLYMOUTH		
Wisconsin	314.00	289.00
Maine	70.00	64.00
New York	22.00	21.00
Minnesota	14.00	1.25
Nebraska	1.00	1.00
Total	421.00	376.25
PONTIAC		
Canada	371.00	248.00
Delaware	20.00	20.00
New Mexico	20.00	20.00
Montana	17.00	17.00
Michigan	10.00	10.00
Idaho	10.00	2.00
Maine	14.00	0.00
Total	462.00	317.00
PROGRESS		
Nebraska	579.13	526.63
Maine	9.00	9.00
South Dakota	5.00	5.00
Wyoming	8.00	3.00
Total	601.13	543.63
PUNGO		
Maine	301.00	295.00
REDBAKE		
Nebraska	11.45	11.45
Minnesota	3.00	3.00
Total	14.45	14.45
RED BEAUTY		
Wisconsin	50.00	37.00
Nebraska	1.50	1.50
Total	51.50	38.50
REDBURT		
Minnesota	52.00	29.00
REDGLO		
Nebraska	1.20	1.20
REDKOTE		
New Mexico	40.00	40.00
Minnesota	18.00	15.50
Colorado	1.25	1.25
Total	59.25	56.75
RED LASODA		
Nebraska	1,830.25	1,731.50
North Dakota	1,476.25	1,238.75
South Dakota	618.00	508.00
Minnesota	460.00	456.00
Wisconsin	473.00	341.00
Colorado	235.13	230.63
Wyoming	187.00	175.00
California	18.00	18.00
Total	5,297.63	4,698.88
RED McCLURE		
Colorado	2,275.50	2,017.50
Wyoming	18.00	18.00
Total	2,293.50	2,035.50
RED PONTIAC		
North Dakota	17,504.00	14,706.00
Minnesota	11,766.80	9,575.30
Canada	2,285.00	2,242.00
Wisconsin	1,261.00	773.00
Colorado	617.46	476.46
South Dakota	626.00	336.00
Nebraska	316.45	266.45
California	182.00	180.00
Wyoming	144.00	140.00
Oregon	—	67.30
Maine	61.00	61.00
Iowa	55.00	55.00
Utah	80.00	23.00
Pennsylvania	16.50	16.50
New York	12.00	12.00
Total	34,927.21	28,930.01
RED SKIN		
New Jersey	5.00	—

	Acres Entered	Acres Passed
RED SPORT TRIUMPH		
North Dakota	19.00	19.00
RED TRIUMPH		
Minnesota	225.00	201.00
RED WARBA		
Minnesota	175.00	152.50
Wisconsin	84.00	83.00
North Dakota	52.00	52.00
Canada	54.00	19.00
Total	365.00	306.50
RUKAT		
New York	1.00	0.00
RURAL NEW YORKER		
Colorado	75.42	75.42
New York	19.00	19.00
Michigan	72.00	12.00
Wisconsin	1.00	0.00
Total	167.42	106.42
RUSHMORE		
Wisconsin	74.00	40.00
North Dakota	51.00	34.00
Minnesota	25.00	25.00
Maine	7.00	4.00
Total	157.00	103.00
RUSSET BURBANK (NETTED GEM)		
Idaho	16,349.00	13,787.00
Canada	4,691.00	3,734.00
Maine	4,729.00	3,517.00
Montana	2,769.00	2,609.00
Oregon	—	2,097.60
Minnesota	1,751.00	1,709.00
California	1,487.00	1,476.00
Wisconsin	1,513.00	1,000.00
Colorado	1,062.50	886.50
North Dakota	208.00	184.00
Utah	201.50	72.00
Michigan	60.00	60.00
Nebraska	46.00	46.00
New Mexico	40.00	40.00
Nevada	3.00	3.00
Total	34,910.00	31,221.10
RUSSET CHEROKEE		
New York	1.00	1.00
RUSSET RURAL		
Michigan	438.00	420.00
Maine	209.00	191.00
New York	202.00	191.00
Colorado	172.58	155.86
Canada	183.00	140.00
Nebraska	48.65	48.65
Wisconsin	19.00	19.00
Total	1,272.23	1,165.51

	Acres Entered	Acres Passed
RUSSET SEBAGO		
Wisconsin	472.00	439.00
Maine	58.00	54.00
Minnesota	3.00	3.00
New Hampshire	0.30	0.30
Total	533.30	496.30
SACO		
Maine	48.00	48.00
Wisconsin	2.00	2.00
New York	1.00	1.00
New Hampshire	0.30	0.30
Total	51.30	51.30
SEBAGO		
Canada	24,602.00	22,296.00
Wisconsin	696.00	658.00
Michigan	632.00	625.00
New York	351.00	351.00
North Dakota	350.00	258.00
Pennsylvania	123.00	123.00
Maine	84.00	82.00
Minnesota	41.00	39.00
Delaware	20.00	20.00
Colorado	1.50	1.50
Utah	2.00	0.00
Total	26,902.50	24,453.50
SEQUOIA		
Michigan	24.00	24.00
Tennessee	12.50	12.50
Maine	12.00	12.00
Wisconsin	7.00	1.00
Canada	25.50	0.50
Total	81.00	50.00
SHERIDAN		
Nebraska	16.00	16.00
TAWA		
Wisconsin	30.00	29.00
Michigan	27.00	20.00
Minnesota	16.50	16.10
Nebraska	1.20	1.20
Total	74.70	66.30
TETON		
Maine	273.00	267.00
Canada	11.00	8.00
Total	284.00	275.00
WARBA		
Canada	347.00	306.00
Maine	32.00	32.00
Minnesota	2.80	2.80
Total	381.80	340.80

	Acres Entered	*Acres Passed*
WASECA		
Minnesota	157.00	153.50
Canada	135.00	109.00
Wisconsin	40.00	40.00
North Dakota	28.00	28.00
Montana	2.00	2.00
Total	362.00	332.50
WHITE CLOUD		
Nebraska	25.20	5.20
Wisconsin	3.00	3.00
South Dakota	1.00	0.00
Total	29.20	8.20
WHITE ROSE		
California	3,576.00	3,570.00
Oregon	—	611.00
North Dakota	604.20	527.20
Idaho	185.00	175.00
Montana	150.00	150.00
Canada	181.00	149.00
Utah	517.00	147.00
New Mexico	50.00	50.00
Nebraska	38.00	38.00
Minnesota	27.50	27.50
Colorado	25.00	25.00
Maine	26.00	22.00
Total	5,379.70	5,491.70
WHITE RURAL		
Pennsylvania	50.00	—
YAMPA		
Minnesota	6.00	6.00
Colorado	3.00	3.00
Total	9.00	9.00

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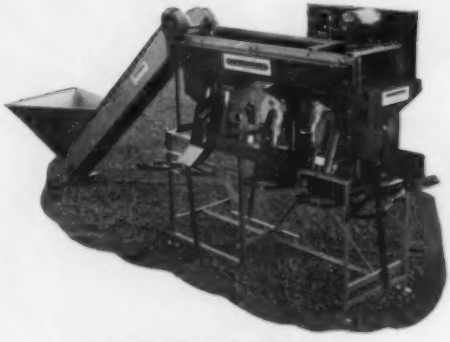

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Agricultural Institute Review, 338 Somerset St., West Ottawa 4, Ont., Canada. Published bi-monthly by the Agricultural Institute of Canada. Editor, Hilda Gray. Subscription price 2.00 per year, foreign $2.50.

American Potato Journal, Potato Association of America, New Brunswick, N. J. Published monthly by the Potato Association of America. Editor, Dr. William H. Martin. Subscription price $4.00 per year. Foreign $5.00 per year. (Includes membership).

American Potato Yearbook, 8 Elm Street, Westfield, N.J. Editor C. S. Macfarland, Jr. Published annually.

The Agronomy Journal, 2707 Monroe St., Madison 5, Wis. Published monthly by the American Society of Agronomy. Editor, L. G. Monthey. Subscription price $14.00 per year.

The American Vegetable Grower, 37841 Euclid Ave., Willoughby, Ohio. Published monthly. Editor, Richard T. Meister. Subscription price, $1.00 per year, 3 years $2.00, Canada and Foreign $1.50 per year.

The Badger Common 'Tater, Fidelty Bank Bldg., Antigo, Wis. Published monthly by the Wisconsin Potato Growers Association, Incorporated. Editor, Harold R. Simons. Price $1.00 per year or free to members.

Buckeye News, 3292 North High St., Columbus 2, Ohio. Editor, V. E. Keirns. Subscription price Free to grower members in Ohio.

California Kern County Potato News, P. O. Box 83, Bakersfield, Calif., official organ of Kern County Potato Growers Association. Published monthly. Editor, Francis P. Pusateri, Executive Manager. Subscription price free to members and associate members. Single copies free upon written request.

Colorado Potato Grower, 2401 Larimer Street, Denver 5, Colorado. Published monthly by the Colorado Potato Growers Exchange. Editor, W. W. Davis. Subscription price $1.00 per year.

Country Life in British Columbia, 207 West Hastings St., Vancouver 3, B. C. Published monthly. Official organ of B. C. Federation of Agriculture. Editor, J. R. Armstrong. Subscription price $1.50 per year, Canada, $2.00, U. S.

Fruit & Vegetable Review, Orange Savings Bank Bldg., Orange, Calif. Published monthly. Editor, A. J. Miller. Subscription price $3.00 per year.

The Guide Post, 5235 North Front St., Harrisburg, Pa. Published monthly by the Pennsylvania Cooperative Potato Growers, Inc. Editor James A. Hannah. Subscription price $5.00.

Hints to Potato Growers, New Jersey Agri. Experiment Station, New Brunswick, N. J. Published monthly by the New Jersey State Potato Association. Editor, John C. Campbell. Subscription price $3.00 per year.

National Potato Council News, 542 Munsey Bldg., Washington 4, D. C. Published monthly by the National Potato Council, Inc.

The North Dakota Seed Journal, published and edited quarter-annually by the State Seed Department, State College Station, Fargo, North Dakota.

The Packer, 201 Delaware St., Kansas City 5, Mo. Published weekly. Editor R. V. Whiting. Subscription price $5.00 per year.

The Potato Chipper, 946 Hanna Bldg., Cleveland 15, Ohio. Published monthly by the National Potato Chip Institute. Editor, Harvey F. Noss. Subscription price $6.00 per year, $7.50 Foreign and Canada.

Potato News, Published by Empire State Potato Club, Inc., Georgetown, N. Y. Editor H. J. Evans. Subscription price—free to members only. Dues $3.00 per year.

Produce Marketing, 251 Kearney Street, San Francisco 8, Calif. Published monthly, official organ of Produce Packaging Ass'n. Robert H. Weait, Editor and General Manager. Subscription price $3.00 per year.

The Produce News, 6 Harrison St., New York City 13. Published weekly. Editor, A. E. Haglund. Subscription price $5.00 per year.

Produce Reporter, 315 W. Wesley St., Wheaton, Ill., published semi-annually. Official organ of the Bluebook, fruit & produce credit book. Subscription price—on contract.

Seeder, P. O. Box 2601, Boise, Idaho. Published periodically by the Idaho Crop Improvement Ass'n. Editor, C. G. d'Easum. Subscription price—free.

"Spuditems," 815 First Avenue, Monte Vista, Colo. Published weekly by the San Luis Valley Potato Board of Control. Editor, V. Craig Johnson. Subscription price —free.

The Spudlight, 777-14th St., N. W., Washington 5, D. C. Published weekly by the Potato Division, United Fresh Fruit & Vegetable Association. Editor, Kris P. Bemis. Subscription price, to individuals and firms not eligible to be members of the United Fresh Fruit and Vegetable Association, $25.00 per year.

Tabb Potato Service, 9 South Kedzie Ave., Chicago, Ill. Editor, L. J. Crescio. Published weekly. Price $50.00 per year. (Also Tabb Onion Service, published weekly, price $50.00 per year).

The Valley Potato Grower, Box 301, East Grand Forks, Minn. Published semi-monthly by the Red River Valley Potato Growers Association. Editor, Lyle W. Currie. Subscription price—free.

Vee Gee Messenger, Preston, Maryland. Published bi-monthly. Editor, Max Chambers. Subscription price 20c per year, $1.00, six years.

Western Grower and Shipper, 606 South Hill St., Los Angeles 14, Calif. Published monthly as the official magazine of the Western Growers Association and the Kern County Potato Growers Association. Editor, Frank Howatt. Subscription price $2.50 per year.

What's New in Crops & Soils, 2702 Monroe Street, Madison 5, Wis. Published nine times a year by The American Society of Agronomy. Editor, L. G. Monthey. Subscription price $3.00 per year.

World Crops, Stratford House, 9 Eden St., London, N.W.1., England. Published monthly. J. Edward Thomas, Associated Editor. Subscription price $8.00 one year, $20.00, 3 years.

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The National Potato Council, Room 542, Munsey Bldg., Washington 4, D. C. Publishers of National Potato Council News. Secretary, Lewis M. Hardison, Richford, N. Y.

National Potato Chip Institute, Inc., 946 Hanna Bldg., Cleveland 15, Ohio. Publishers of "Potato Chipper." Executive Secretary, Harvey F. Noss, Cleveland.

United Fresh Fruit and Vegetable Association, Potato Division, 777 14th St. N.W., Washington 5, D. C. Publishers of "Spudlight". Exec. Vice-Pres., C. W. Kitchen, Secretary, Potato Division, Kris P. Bemis, 777 14th St., N.W., Washington 5, D. C.

Vegetable Growers Association of America, Inc., 528 Mills Building, 17th and Pennsylvania Ave., N.W., Washington 6, D. C. Official Publication—Vee-Gee Messenger. Secretary, Joseph S. Shelly, Washington.

Alaska Crop Improvement Association, Box E, Palmer, Alaska. Secretary, Charles E. Logsdon, Agri. Exp. Sta. Palmer.

Queen Creek Potato Growers Association, 350 Terminal Bldg., Phoenix, Arizona. Secretary-Treasurer, D. D. Atkinson, Phoenix.

Kern County Potato Growers Association, Inc., P.O. Box 83, Bakersfield, Calif. Publishers of "Kern County Potato News". Executive Mgr., Francis P. Pusateri, P.O. Box 83, Bakersfield.

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The Center Potato Growers Co-op Association, 715 E. 3rd St., Center, Colo. Manager, George E. McDaniel, Center.

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Monte Vista Potato Growers Coop. Association. Monte Vista, Colo. Secretary, O. E. Drake, Monte Vista.

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San Luis Valley Potato Administrative Committee, Bank Bldg., Monte Vista, Colo. Publishers of "Spuditems."

San Luis Valley Potato Improvement Association, Box 150, Monte Vista, Colo. Secretary, W. J. Wonders, Monte Vista.

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Connecticut Vegetable Growers Association, Inc., Maple Shade Rd., Middletown, Conn. Official Publication—Annual Report and Vegetable News. Secretary, Frank W. Roberts, Maple Shade Rd., Middletown.

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Florida Potato Council, (A division of the Florida Fruit and Vegetable Association), 4401 East Colonial Drive, Orlando, Fla. Secretary-Treasurer, Joffre C. David, Orlando.

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Idaho Grower Shippers Ass'n., Inc. P.O. Box 1100, Idaho Falls, Idaho. Secretary-Manager, Ed. Moore, Idaho Falls.

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Maine Potato Growers, Inc., Presque Isle, Maine.

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Red River Valley Potato Growers Association, Box 301, East Grand Forks, Minn. Publishers of "The Valley Potato Grower." Executive Secretary, Lyle W. Currie, East Grand Forks.

Potato Certification Ass'n. of Nebraska, P.O. Box 90, Alliance, Neb. Manager, Phil Hoff, Alliance.

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Nebraska Potato Development Division, Box 277, Scotts Bluff, Neb. (Publishers of "Mailbag"). Acting Chief, J. C. Peterson, Scotts Bluff.

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New York Co-operative Seed Potato Association, Inc., Georgetown, N. Y. Publishers of "Potato Patter." Secretary-Treasurer, Harold J. Evans, Georgetown.

Suffolk County Farm Bureau, Court House, Riverhead, L.I., N.Y. Publishers of Suffolk County Farm News. Secretary, Kenneth L. Wells, Jr., Sound Ave., Riverhead, L.I., N.Y.

North Carolina Potato Association, P.O. Box 2281, Raleigh, N. C. Secretary, Hugh B. Martin, P.O. Box 2281, Raleigh.

Ohio Vegetable and Potato Growers Association, Room 211, Horticulture Bldg., Ohio State University, Columbus 10, Ohio. Publishers of "Annual Proceedings." Secretary, E. C. Wittmeyer, Horticulture Bldg., Columbus.

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Pennsylvania Cooperative Potato Growers, Inc., 5235 North Front St., Harrisburg, Pa. Publishers of "The Guide Post." General Manager, Owen L. Barkley, 5235 N. Front, Harrisburg; Secretary and Educational Director, James A. Hannah, 5235 N. Front, Harrisburg.

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Pennsylvania Potato Industries, Inc., Potato City, Coudersport, Penna. (Publishers of Potato Receipts). Secretary, James A. Hannah, 5235 North Front St., Harrisburg, Pa.

Rhode Island Potato Growers Association, 83 Park St., Providence, R. I. Secretary, Roland L. Swallow. Providence.

South Dakota Potato Growers Association, Box 671, Watertown, S. Dakota. Publishers of "Rules and Regulations for Certification". Secretary, John Noonan, Watertown.

Associated Growers of Hereford, Box 302, Hereford, Texas.

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Pemberton Seed Potato Control Area Association, Pemberton, B. C.

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Manitoba Vegetable and Potato Growers Co-operative, 20 Derby St., Winnipeg, Manitoba.

Vegetable Growers' Association of Manitoba, 153 Legislative Bldg., Manitoba. Official Publication—Annual Convention Proceedings. Secretary-Treasurer, F. J. Weir, 153 Legislative Bldg., Winnipeg.

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Ontario Soil and Crop Improvement Association (Potato Section), Ontario Department of Agriculture, Parliament Bldg., Toronto, Ont. Publishers of Potato Peelings. Secretary, Potato Section, R. E. Goodin, Parliament Bldg., Toronto.

South Simcoe 500 Bushel Potato Club, Dept. of Agri., Alliston, Ont.; Secretary-Treas., J. Keith McRuer, Alliston.

Prince Edward Island Potato Growers' Association, P.O. Box 218, Carlottetown, P.E.I.

Prince Edward Island Potato Promotional Committee, Charlottetown, P.E.I.

Catholic Farmers Union, Market, Garmeneu Section, 515 Viger Ave., Montreal, Q. Q.

Provincial Potato Protection Committee, Department of Agriculture, Parliament Bldgs., Quebec, Publishers of Potato Protection Guide.

Saskatchewan Certified Potato Growers' Association, Extension Dept., University of Saskatchewan, Saskatoon, Sask.

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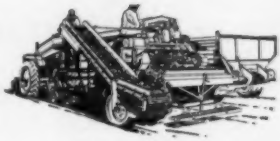

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